Accutorr Plus™

Service Manual

Datascope
Patient Monitoring
A MINDRAY GLOBAL COMPANY

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On the first page of each chapter a table of contents for that chapter is provided.

This is a Service Manual for the Accutorr Plus monitor. **There are no Operating Instructions in this manual. Complete operating instructions and listing of available accessories are published in the Accutorr Plus Operating Instructions—P/N 0070-00-0692-02 (English) and P/N 0070-00-0695 (international languages).**

Foreword

This Service Manual (P/N 0070-00-0691) is intended as a guide, for technically qualified personnel, to use during repair and calibration procedures for the Accutorr Plus (part number 0998-00-0444-9XX).

Use this Accutorr Plus Service Manual ONLY for the monitor part numbers listed below. This manual provides specific information that may not be applicable to other part numbers.

The part number (P/N) and serial number are necessary for positive identification of the correct parts. They are located on the rear panel label of the Accutorr Plus unit.

MONITOR PART NUMBER (P/N)	MONITOR CONFIGURATION
0998-00-0444-91A	Basic (NIBP only) (IEC, English)
0998-00-0444-91G	Basic (NIBP only) (IEC, German)
0998-00-0444-91P	Basic (NIBP only) (IEC, Spanish)
0998-00-0444-91F	Basic (NIBP only) (IEC, French)
0998-00-0444-91T	Basic (NIBP only) (IEC, Italian)
0998-00-0444-93A	Advanced (Nellcor®) (IEC, English)
0998-00-0444-93G	Advanced (Nellcor®) (IEC, German)
0998-00-0444-93P	Advanced (Nellcor®) (IEC, Spanish)
0998-00-0444-93F	Advanced (Nellcor®) (IEC, French)
0998-00-0444-93T	Advanced (Nellcor®) (IEC, Italian)
0998-00-0444-94A	Advanced (Masimo®) (IEC, English)
0998-00-0444-94G	Advanced (Masimo®) (IEC, German)
0998-00-0444-94P	Advanced (Masimo®) (IEC, Spanish)

MONITOR PART NUMBER (P/N)	MONITOR CONFIGURATION
0998-00-0444-94F	Advanced (Masimo®) (IEC, French)
0998-00-0444-94T	Advanced (Masimo®) (IEC, Italian)

Notes and Precautions

NOTES are a general information statement concerning the Accutorr Plus.

A **CAUTION** is provided to alert the user to use special care necessary for the safe and effective use of the device. They may include actions to be taken to avoid effects on patients or users that may not be potentially life threatening or result in serious injury, but about which the user should be aware. Cautions are also provided to alert the user to adverse effects on this device of use or misuse and the care necessary to avoid such effects.

Please read and adhere to all notes and precautions listed here and in the appropriate areas throughout this manual.

Notes

NOTE: **See the serial and product number label on the rear panel of the unit for part number identification. This manual also includes information on the optional Recorder and Predictive Temperature modules and Infrared Temperature module.**

NOTE: **This manual does not provide operating instructions. Consult the Operating Instructions Manual for proper operation of this monitor.**

NOTE: **Unauthorized servicing may void the remainder of the warranty. Check with the factory or with a local authorized representative to determine the warranty status of a particular instrument.**

NOTE: **Do not change Room Number and /or Bed Letter on the Accutorr Plus during the transmission of temperature data.**

NOTE: **The AccuTemp IR thermometer should be at room temperature when it is used. If it has been in a very warm or very cold environment it may need time for the thermometer temperature to equalize to ambient temperature.**

NOTE: **Special care should be taken to insure that the front panel and glare screen are not scratched.**

NOTE: **New batteries are shipped in a discharged state for safety reasons. A new battery must be charged for 4 hours for Li-Ion before first use. The monitor may be used with AC mains power during the charge cycle but battery operation could be limited during this time.**

NOTE: **Mindray DS USA, Inc. maintains a policy of continuous development for product improvement and reserves the right to change materials, specifications, and prices without notice.**

NOTE: **When replacing a Keyboard, you must replace the Graphic Panel.**

NOTE: **Monitors with Nellcor® and Masimo® SpO_2 do not report SpO_2 Runtime and Boot Software Versions.**

NOTE: **The Accutorr Plus always displays time in a 24 hour format.**

Precautions

CAUTION: Li-Ion batteries used in this device may present a risk of fire or chemical burn if mistreated. Do not disassemble, heat above 100°C (212°F), or incinerate. Replace battery with P/N: 0146-00-0069 only. Use of another battery may present a risk of fire or explosion.

CAUTION: Dispose of used battery properly. Keep away from children. Do not disassemble and do not dispose of in fire.

CAUTION: Soldering and solder removal equipment must be low voltage operated and grounded to avoid static charge and stray current induced component damage. Maximum wattage: 25 W.

CAUTION: The Inside Of This Instrument Contains Static Sensitive Components. Use correct static protection safeguards.

This publication may have been updated to reflect product design changes and/or manual improvements. This manual is correct to the best of our knowledge at the time of publication and reflects the product variations shown in this manual. You may contact Technical Support to confirm that the manual is applicable for your unit. Updated manuals are available for sale.

1.0 Theory of Operation

1.1 Major Functional Blocks of the Accutorr Plus 1-2
1.2 CPU/NIBP Module Assembly with LCD Display 1-3
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1.5 LED and Tone Module 1-16

This section of the manual explains the basic architecture of the Accutorr Plus. It is an overview, not a detailed circuit analysis. It is intended to be a tool, that if used properly, will lead to an understanding of the functions executed by a major functional block, and thus enabling a logical isolation and resolution of malfunctions.

The Accutorr Plus is offered in many functional configurations, including the options licensed and manufactured by third parties. The third party circuits will be treated solely as “black box” devices, with only the relevant input, output and power sources described.

The Theory of Operation section describes only the highest configuration level. Units built with fewer or different options may not use all of the capabilities of the Accutorr Plus, yet the over-all theories will remain constant.

1.1 Major Functional Blocks of the Accutorr Plus

- CPU/NIBP Module Assembly with LCD Display
- Interface and SpO_2 Processor Board
- Main Power Supply and Battery Charger Assembly
- LED/Tone Module Assembly

1.2 CPU/NIBP Module Assembly with LCD Display

The Accutorr Plus CPU/NIBP module controls the functions of the NIBP, temperature probes, and SpO_2 module; transmits output data to the recorder; and provides a serial I/O port connection for PC communication.

The CPU/NIBP module distributes power from the power supply, which includes power and control signals to the LED/Tone module, to the remaining components of the system such as the recorder and SpO_2 modules. The CPU/NIBP module also supplies separate power to the LED backlight and provides trend data to the display.

The CPU/NIBP circuit board is comprised of both software and hardware. The following is a summary of the software control exercised and the major hardware affected. This is for informational purposes only, and both software and hardware controls may be changed at any time without notice.

1.2.1 Software Overview

The software performs the following functions:

1. Initializes hardware and software modules
   - Microcontroller ports and communication (serial) interfaces
   - Software entry points and variables
   - Read configuration from NVRAM
2. Performs power up diagnostic
   - Microcontroller, FLASH, and STATIC RAM test
3. Performs NIBP functions
   - Start measurement
   - Repeat measurement
   - Over pressure limit
   - Enter or exit test mode
   - Abort measurement
   - Enter or exit calibration mode
   - Update alarm limits
   - Report alarm status
   - Report data
   - Determine inflation pressure
   - Perform controlled cuff deflation
   - Monitor DC and AC pressure and acquire pulsations
   - Reject artifacts
   - Decide on termination point and exhaust cuff pressure
   - Smooth pulsation data
   - Determine systolic, mean, diastolic pressure and heart rate
   - Check alarm conditions

4. Transmits/Receives data to/from Infrared/Predictive Temperature modules
5. Manages Recorder functions
6. Manages Keypad interface
7. Provides RS232 communication to PC for software download
8. Supports Service Diagnostics
9. Supports Nurse Call feature
10. Checks error conditions
    - Maintain watchdog timer
    - Run-time diagnostic
11. Transmits/Receives data to/from SpO_2 module, if present
12. Controls LCD view angle

1.2.2 CPU Hardware Controls

1. Microcontroller executes the above software functions, including:
    - NIBP
    - Recorder
    - Temperature module, PTM or IR
    - SpO_2
    - LCD
2. Battery Back Up Circuitry for Power Savings
    - Static memory
    - Non-volatile RAM for configuration and future serial number
3. Flash ROM for Program Storage and Execution
4. Static RAM for Data Storage
5. RS232 level translation for PC Download and second interface for CIS/HIS
6. Real time clock with 16K of Lithium backed up NV RAM

1.2.3 NIBP Hardware functions

1.2.3.1 Main pressure transducer circuitry

A pressure transducer and amplifier combination is provided to acquire the cuff pressure signal.

1.2.3.2 Over pressure transducer circuitry

An over pressure transducer, independent of the main pressure transducer. Over pressure limits are set according to the patient size.

1.2.3.3 Five A/D channels

All channels are at 12-bit resolution and digitized at 101 Hz:

1. DC pressure
2. AC pressure (pulse)
3. Hardware over pressure transducer
4. Hardware over pressure cooperator reference
5. Battery voltage monitoring, when the Accutorr is in battery operation

1.2.3.4 Pulse Channel Filter

A high-pass filter is provided to isolate the pulsatile component from the DC cuff pressure. This pulsatile component is digitized as the pulse channel. The gain of this AC coupled channel is programmable in a manner consistent with the specified range of pulse amplitudes.

1.2.3.5 Inflation Pump

A pump capable of inflating the cuff within the specified time limit.

1.2.3.6 Bleed Valve

A valve and control system capable of bleeding down the cuff pressure.

1.2.3.7 Dump Valve

A valve to rapidly discharge the residual cuff pressure at the end of the measurement cycle.

1.2.3.8 Cuff Inflation Requirements

The cuff is initially inflated to a software-determined pressure dependent upon patient size. In timer mode, it should be a predetermined increment, traditionally 50 mmHg (40 mmHg for Neonates) (determined by the CPU), above the previous systolic reading, after the first measurement. The software detects error conditions in the pneumatic system such as disconnected cuffs or kinked hoses. To reduce the possibility of over inflating the cuff, the pump may be driven at a lower speed when pressurizing small neonatal cuffs. This is achieved by pulse width modulating the pump control signal. Further control of the neonatal inflation rate may be achieved by using the bleed valve to relieve some portion of the pump's delivery.

1.2.3.9 Pulse Acquisition Requirements

Pulse amplitudes from 0.06 mmHg to 12 mmHg are recognized. Pulse rates can range from 30 bpm to 250 bpm. The software discriminates pulses from the digitized pulse channel signal, and characterizes the pulses for amplitude, DC pressure, and pulse period. False triggering, due to the dicrotic notch or noise, is minimized.

1.2.3.10 Artifact Rejection Requirements

The software provides means of artifact rejection, both during acquisition and during subsequent processing of the pulse array. Means of rejecting artifacts include attention to the timing and amplitude of pulses relative to adjacent pulses. If motion artifact is detected during acquisition, the software may cause temporary suspension of the bleed down process until a quiescent patient condition returns.

1.2.3.11 Parameter determination Requirements

Pulses that are deemed acceptable after artifact processing are entered in the pulse array. Heart rate is taken to be the average rate of the pulse array data. Pulse periods differing excessively from the median are ignored. Pulses that do not appear to fit the amplitude envelope are removed. The systolic, diastolic, and mean pressures are then calculated in accordance with standard algorithms. A fair amount of data manipulation and computation is required in the parameter determination. The results are reported no more than one second from the termination of the pulse acquisition phase.

1.2.4 Major Hardware Components

1.2.4.1 CPU

A microcontroller (min. 16MHz) with three (3) serial communication controllers (SCC), a serial communication port (SCP), programmable chip select lines (to minimize glue logic), a IDMA controller, and parallel I/O ports for discrete signals.

1.2.4.2 Flash Memory

512K x 16 Flash ROM used for program storage and execution. A Flash ROM is used also for downloading new revisions of software via the CPU's serial I/O lines (SCC).

1.2.4.3 Battery Backed Up Static RAM

512K x 16 static ram is used for data storage, trend information, etc. This memory is used for data storage. Therefore, a battery back up is provided.

1.2.4.4 Nonvolatile RAM

Nonvolatile ram is used for configuration and serial number information. This memory requires a battery back up.

1.2.4.5 Micromanager

This device provides a number of features that are useful for management of this board. They are listed as follows:

A. ON/STANDBY capability through keyboard control

B. Watchdog timer

C. Conversion of CMOS SRAM to pseudo nonvolatile memory

1.2.4.6 Battery Backup Voltage Regulator Circuitry

Implements regulation of the STANDBY VOLTAGE from the main power supply to 4V +/- 0.2V dc with a current draw of 821 uA max.

1.2.4.7 Real Time Clock

This device provide seconds, minutes, hours, date of the month, month, and year with leap year compensation. The device is memory mapped to be pointed to as software requires. Also, provisions for running this device include main power supply and battery operation in order for the RTC to keep time when the system is not powered. A lithium battery is included, having a minimum of 10 years of operation, for configuration and clock data retention during battery changes and main battery failure. Accuracy is +/- 1 minute/week.

1.2.4.8 Recorder Interface

IDMA capability for writing 8-bit buffered parallel data to the recorder. Handshaking signals to specify new line to be printed, request for next byte of data.

1.2.4.9 Communication Block

The module provides the following interfaces and functions:

- RS-232E drive from TTL levels. RS-232E driver for CIS/HIS that will provide minimum of 9V signal level.
- IC based DC/DC converter capable of converting VCC to 12VDC, with leakage current when off < 100uA. High frequency operation to limit emitted fields. Capable of providing an output current of 125 mA @ 12Vdc, with an efficiency of 80% or higher.
- Signal driver for an external isolated relay that will be used for Nurse Call, provided on pins of the 9-pin RS-232 connector.

The RS-232E interface required is implemented using a Maxim, MAX236 Multi-Channel Transceiver (U602). This chip was chosen because it has a minimum ±9 volt output signal level. Communication is to support a 5 wire interface, 4 signals and a ground. The signals are described below:

SIGNAL	DESCRIPTION	INPUT/OUTPUT
RXD	Received Data from DCE to DTE device	Input
TXD	Transmitted Data from DTE to DCE device	Output
RTS	Request to send from DTE to DCE device	Output
CTS	Clear to Send from DCE device	Input
GND	Signal Ground	Input

All RS-232 signals are ESD protected by a U603, an SM14M24C Transient Voltage Suppressor array. The +12 VT dc power required by the Nurse Call cable is supplied from the onboard DC/DC converter. The MAX236 receivers are controlled by logic signal CSTAT*. Logic 0 enables the receivers; otherwise, they are tri-stated.

The RS-232 signals appear on connector J603, a dual row 14 pin header which will have a mating 14 pin pendant ribbon cable attached. The other end of the ribbon cable assembly is a 9 pin panel mount ‘D’ connector.

1.2.4.10 Backlight LED Driver

The LED driver module is implemented with Linear LT3474, step-down 1A LED driver. It can source constant current maximum up to 1A. The current can be programmed by setting the voltage at Vadj pin (pin 13) through resistors R42 and R14. The switching frequency is programmed to 300KHz for best duty cycle (i.e, 96%) for higher efficiency. The typical LED drop voltage of 3.5V is achieved by programming the constant output LED current of 71mA. The Vadj is sourced from external voltage source (i.e., +5V VCC) by external resistor divider.

1.2.4.11 LCD Trend Display

DAC control provided from the LED/Tone Board controls the LCD View Angle.

1.2.4.12 Temperature Interface

The board provides a Serial Interface to either Temperature module.

1.2.4.13 SpO_2 Interface

The board provides a Serial Interface to SPO_2 and reset control of the module.

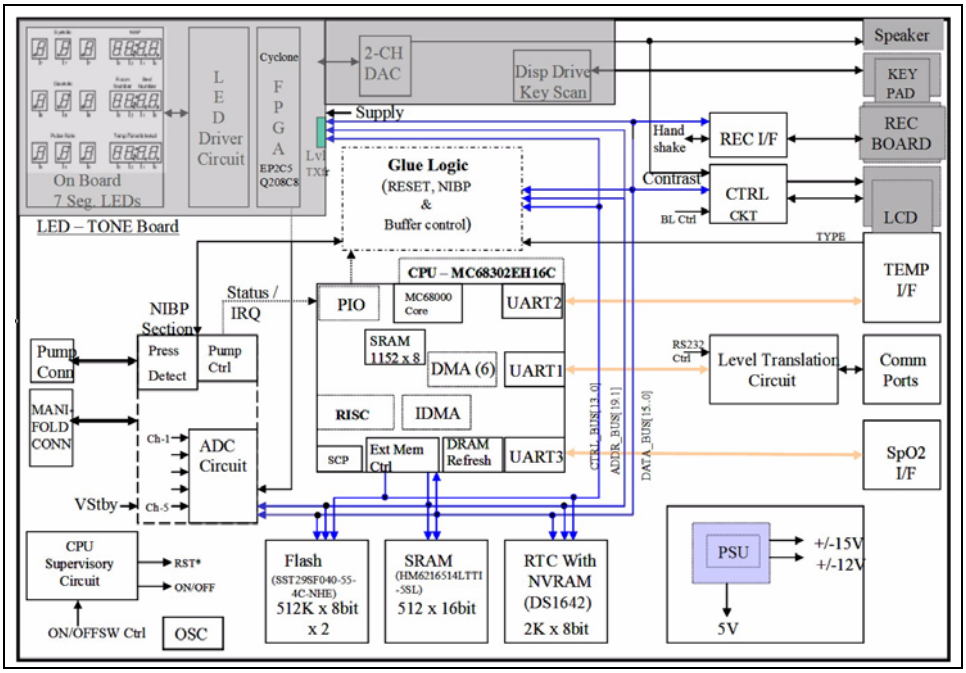

FIGURE 1-1 CPU Block Diagram

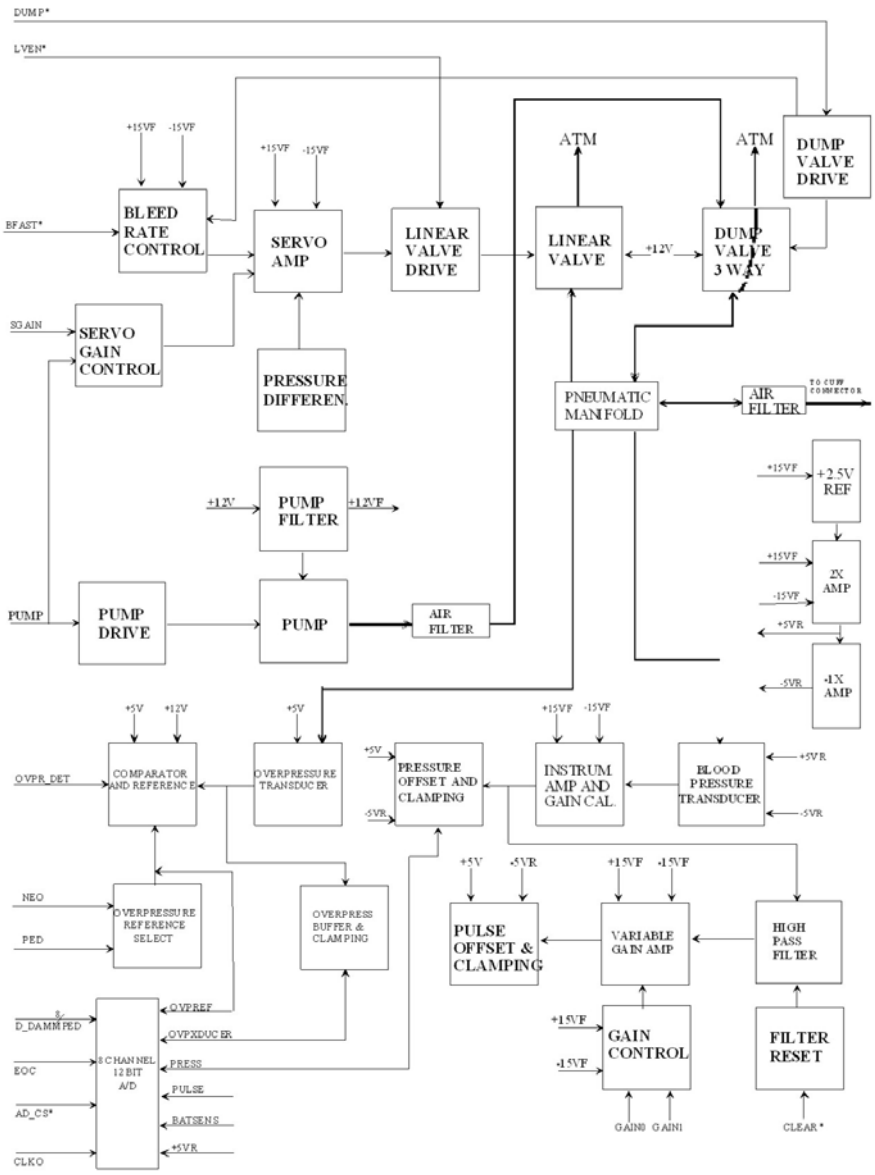

FIGURE 1-2 NIBP Block Diagram

1.3 SpO_2 Processor Circuit Boards

The Accutorr Plus can be equipped with one of two optional technologies:

- Nellcor® SpO_2 system
- Masimo® SpO_2 system

Each technology uses proprietary sensors and interface cables. There are no "adapters" possible or available.

1.3.1 SpO_2 General Theory Of Operation

Regardless of manufacturer, SpO_2 determination is based on the relative attenuation of a red and an infrared light source. A sensor from the instrument contains two sets of LEDs to illuminate a portion of the body (for example, a fingertip) and a single photo sensor detects the light returned. The LEDs are alternately pulsed, red and infrared. Since hemoglobin is the carrier of oxygen in the blood and the relative attenuation of the light sources is proportional to the amount of oxygen carried by the hemoglobin, a relative level of saturated hemoglobin can be determined. Since we are measuring the ratio of red and infrared return from the circulatory system, the detection method is substantially independent of skin color or total skin attenuation. Since the blood flow has a pulsatile characteristic, a pulse rate can also be computed from this information.

NOTE: There is no calibration possible for the determination of the SpO_2% or of the pulse rate derived. As mentioned above, we are measuring a ratio of intensity of two light sources to determine the % of saturated hemoglobin. The determination is based on proprietary software interpretation of the reflected light ratios, and it is validated against strict clinical trials where fresh arterial blood is examined with a clinical blood gas analyzer. Once the software is finalized, the SpO_2 monitor accuracy is fixed and there are no possible adjustments.

NOTE: The wavelengths of the light emitted are nominally 660nm and 890nm with the energy not exceeding 15mV.

1.3.2 Nellcor® Nell-3 SpO_2 Circuit Board Theory of Operation

The Nell-3 is a complete SpO_2 detection and determination circuit, proprietary of Nellcor® Puritan Bennett. Patient data is processed for serial transmission to the host system.

1.3.3 Nellcor® Nell-3 Interface Board Theory of Operation

The Nellcor® Nell-3 interface circuit board (0670-00-0740) establishes bilateral communication and control of the Nellcor® Nell-3 oximeter circuit board. The circuit board consists of a power supply section that converts the system +5 VDC into the logic and analog supplies required by the oximeter, and optically isolated logic control for the processing circuits of the oximeter. A 5V to 10V DC/DC converter (T1) and two voltage regulators (U4 and U5) generate the required digital (+5VD) and analog (+5VA) voltages. Regulator U4 also provides optocoupler U1 and protection array U6 with power. The logic control section, consisting of U1, U2 and U3, provide the buffer and isolation from the main CPU circuit to the Nellcor® Nell-3 oximeter section.

1.3.4 Masimo SET® Technology

Masimo SET® Technology combines advances in fundamental sensor technology, digital signal processing, an easily portable platform, and a low noise hardware platform incorporating multiple wavelengths applicable to many physiological parameters. Masimo SET® Technology is composed of three components: (1) new signal processing apparatus, (2) a new method for in vivo measurement, and (3) new sensor technologies. The main benefit of Masimo® technology is the effective cancellation of unpredictable “in-band noise” (noise that is in the same frequency, phase, and/or amplitude space as the desired signal). Conventional fixed filters, whether analog or digital form, have been designed to pass certain frequencies while rejecting others.

For example, a bandpass filter with a lower cut-off frequency of 1Hz and an upper cut-off frequency of 10Hz will pass all frequencies between 1Hz and 10Hz and reject frequencies below 1Hz and above 10Hz. Therefore, any “noise” that has a frequency outside the pass band is rejected and not considered (i.e., 120Hz due to room light and 60Hz noise from electrical lines).

However, if noise exists between the pass band of 1Hz and 10Hz, it will enter the system with the desired signal and corrupt the measurement (i.e., patient motion at 2Hz). Fixed filters will always have this limitation. Masimo® has overcome these problems by developing a novel technique to accurately determine the noise reference (patents issued and pending); thus, making adaptive filters work in real-time even when applied to medical monitoring of widely variable and unpredictable patients. With this new technique, Masimo® is able to solve the perennial problem of motion artifact in pulse oximetry. Further technical information is available from Masimo® on the Internet at www.masimo.com.

1.3.5 Masimo® Interface Board Theory of Operation

The Accutorr Plus Masimo® interface board (P/N: 0670-00-0716) provides an isolated data and power interface between the Accutorr Plus and the Masimo® MS-3 Pulse Oximetry module. The patient isolation requirement for the Masimo® section is 1500VAC, less than or equal to 1mA leakage current, from input connectors J1 and J4-all terminals to J2-all terminals.

The isolated DC/DC converter, T1, supplies the regulated +5DIG as required by the Masimo® MS-3 Pulse Oximetry module. The digital 5V is then utilized to generate the analog 15V used by the MS-3. The optocouplers (U1 and U2) isolate the signals used for bidirectional serial communication with the Masimo® MS-3 Pulse Oximetry module. Control signal SpO_2 COMM at J4 will allow the Accutorr Plus software to interrupt the serial transmission for future options. All data and control lines interfaced to the SpO_2 module are opto-isolated. Power to the SpO_2 module is isolated by a DC/DC converter with the input coming directly from the CPU/LED module.

1.4 Main Power Supply

There is one power supply used in the Accutorr Plus. P/N 0014-00-0083-02 is configured for the use and charge of a Lithium Ion battery, P/N 0146-00-0069.

1.4.1 Description

The power supply provides four regulated DC output voltages for the Accutorr Plus. The power supply can operate from an AC line or a lithium ion battery and will automatically select the source of power available to the monitor, with priority given to the AC line. In addition, the power supply can operate normally from the AC line without the battery or with a battery cell shorted.

The power supply consists of two basic blocks. The first block is an AC to DC converter, which consists of a universal AC input switching regulator and a battery charger for the lithium ion battery. The second block consists of DC to DC converters that will supply +5V, +12V, +/-15V. Power to the DC to DC converters is "ORed" from either the battery or the output of the AC to DC converter. The power supply continuously monitors the battery voltage and temperature to charge the battery as required.

1.4.2 Power Supply Output Voltages

VOLTAGE	TOLERANCE	MAXIMUM CURRENT
+5 volts	±2%	2.63 amps
+12.5 volts	±5%	0.55 amps
±15 volts	±3%	±100mA
Standby	7.7V to 13.6V	17mA

1.4.3 Lithium Ion Battery and Charger

- Battery: 11.1V Lithium Ion battery (3S2P, 4.4 Ah min), P/N: 0146-00-0069
- Battery charger: fully charges the Lithium Ion battery (P/N 0146-00-0069) within a max. of 4 hours (with the monitor in STANDBY mode), and not overcharge if left on continuously. The power supply automatically reduces the charging current during peak power demands on the +5V and +12.5V outputs.
- Battery temperature: monitored with NTC thermistor Semitec P/N 103AT-2.
- Charge temperature: 0ºC to 50ºC
- Discharge temperature: -10ºC to 60ºC
- Charger power requirements: Nominal power (during current-limit mode) decreases linearly from 28W to 0W; maximum power (during fast charge) is 31.5 W max.

- Low battery shutdown: Automatic shutdown of all DC outputs when the battery voltage is 9.1V ±4%. Remaining load on the battery is less than 5 mA.

  When the remote On/Off switch is enabled and the AC input is not available, power is delivered regardless of the charge on the battery as long as battery voltage is greater than the low battery shutdown voltage. This insures that the system could be operated with a battery that is not fully charged.

- Enable after shutdown: If the AC input is not available after battery replacement, power is delivered when the remote On/Off switch is enabled as long as the battery voltage is 9.9V minimum.

1.5 LED and Tone Module

The Accutorr Plus LED/Tone module performs four main tasks: 1) It drives all the 7-segments and discrete LED user displays on the keypad; 2) it generates an IEC60601-1-8 compliant alarm signal via the onboard Digital-to-Analog-Converter (DAC) and drives advisory tones to the speaker by the onboard power amplifier; 3) it controls the interface between the main CPU and the keypad; the functionality on the module is accomplished by the use of a Field Programmable Gate Array (FPGA) device; and 4) DAC drives view angle of trend display.

The LED/Tone module is under direct control of the CPU/NIBP module for inputs, and converts the input data into LED segment drive as well as the audio tones for advisory and alarm conditions.

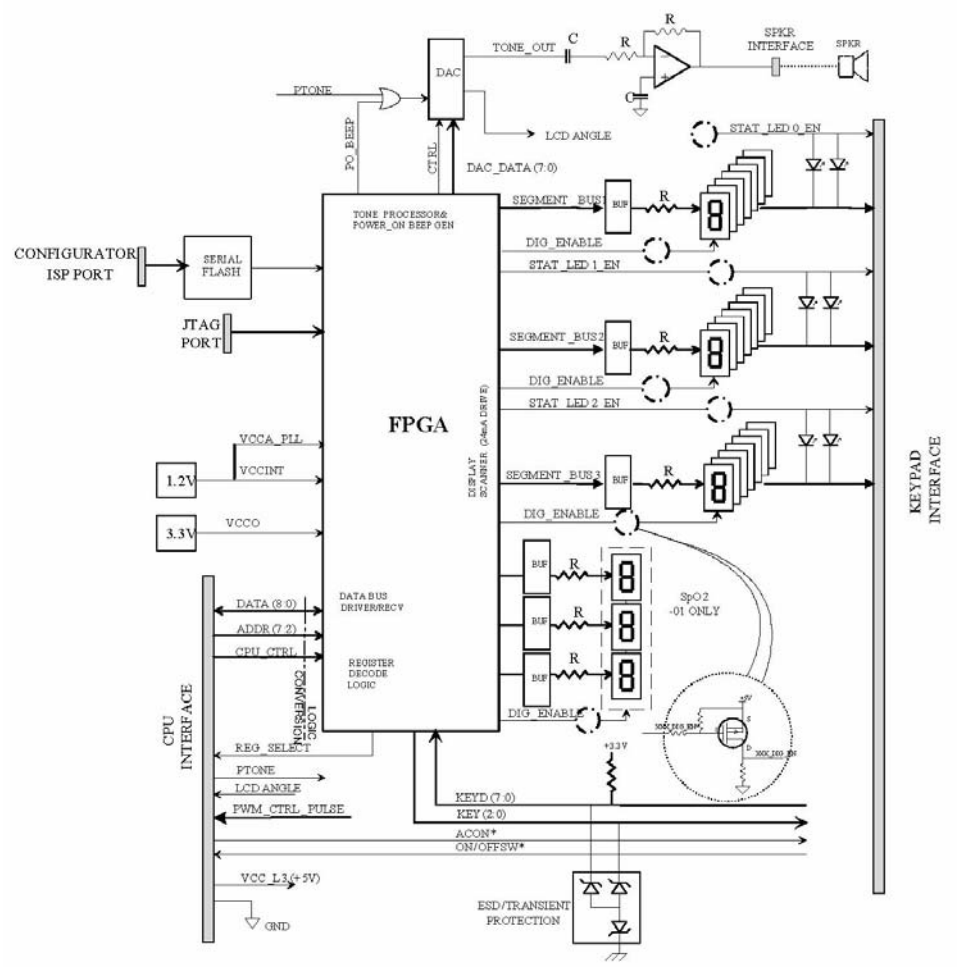

FIGURE 1-3 LED/Tone Module, Functional Block Diagram

1.5.1 Keypad Control

Circuitry for scanning the keypad for key presses. The board scans a 3x8 matrix of keys. In the case of simultaneous key presses, a key is recognized by the software. The other key will not be recognized, until the initial key is released.

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2.0 Specifications

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2.1 Performance Specifications

Systolic and Diastolic Pressure Readout

Number of Digits:	3
Accuracy*:	Mean error $\leq$ ±5 mmHg Standard deviation $\leq$ ±8 mmHg
Range:	Adult Mode: 55 to 260 mmHg Pediatric Mode: 55 to 160 mmHg Neonatal Mode: 45 to 120 mmHg

* *Tested per ANSI/AAMI SP10-1992 methods.*

2.1.1 NIBP Measurement Cycle Time

Less than 30 seconds average at 80 BPM with 180 mmHg pump up pressure, without retries, motion artifact, or arrhythmia with standard adult cuff on a healthy individual. Cycle time is affected by arm size and wrapping technique.

2.1.1.1 Pulse Rate

Range:	35-245 BPM for Adult and Pediatric 70-245 BPM for Neonate
Display Resolution:	1 BPM
Accuracy:	±3 BPM or ±3%, whichever is greater

2.1.2 Maximum Cuff Pressure

Two means of limiting cuff pressure are provided: 1) a hardware over pressure monitor that limits the pressure to 330 mmHg for Adults, 220 mmHg for Pediatrics, and 165mmHg for Neonates; 2) a software overpressure monitor that vents if the pressure exceeds 300 mmHg for Adults, 200 mmHg for Pediatrics, and 157 mmHg for Neonates. If the hardware over pressure circuit is tripped in normal operation, then the unit must be turned off and on to reset the system.

2.1.3 Inflation Source

This inflation source is capable of supplying sufficient air to bring a volume of 700 cc's to a pressure of 300 mmHg in no more than 35 seconds. If the cuff is not inflated to the desired pressure within 60 seconds, then the cuff is vented and a retry cycle is initiated.

2.1.4 Leak Rate

With the bleed valve closed, the maximum pressure drop is 10 mmHg in 90 seconds measured with a 700 cc volume at a differential pressure of 250 mmHg.

2.1.5 Cuff Vent Rate

When the unit is vented, a volume of at least 700 cc's is reduced from a pressure of 250 mmHg to a pressure of 20 mmHg in a maximum of 14 seconds.

2.1.6 Temperature (Predictive)

Range:	90-110°F, 32-43°C
Display Resolution:	0.1°F, 0.1°C
Accuracy:	Meets ASTM E1112-2006 for accuracy

2.1.7 Nellcor® SpO_2

Range:	70-100% SpO_2
Display Resolution:	1% SpO_2
SpO2 Response Time:	4.5 to 6.5 seconds
Display Update:	Less than 4 seconds
Calibration:	Factory Calibrated to Functional Saturation
Accuracy*:	± 2 digits from 70 - 100% SpO_2 - Adult ± 3 digits from 70 - 100% SpO_2 - Neonates <70% unspecified
Pulse Rate Range:	21 to 249 BPM

** Neonatal accuracy specifications are based upon testing the N-3000 and N-25 neonatal sensors on healthy adult volunteers in induced hypoxia studies, in the range of 70 - 100% SpO2. The specified accuracy also takes into account published literature which predicts that there may be a small difference in % of SpO2 reported by the oximeter when measurements from adult and fetal blood with 100% fetal hemoglobin are compared. Fetal hemoglobin is present in concentrations varying from 10% to 90% in neonatal blood, and this percentage declines over time. As the percentage of fetal hemoglobin in neonatal blood declines, the theoretical effect on accuracy due to this source is reduced.*

2.1.8 Masimo® SpO_2

Range:	70-100% SpO2
Display Resolution:	1% SpO_2
Display Update:	< 4 seconds

SpO2 Accuracy Saturation during No Motion Conditions[1]

Adults / Pediatrics:	70% to 100% ± 2 digits[5] <70% unspecified
Neonates (LNOP/LNCS):	70% to 100% ± 3 digits

SpO2 Accuracy Saturation during Motion Conditions[6]

Adults / Pediatrics[2]:	70% to 100% ± 3 digits <70% unspecified
Neonates[3] (LNOP):	70% to 100% ± 4 digits
Neonates[3] (LNCS):	70% to 100% ± 3 digits <70% unspecified
SpO_2 Response Time:	10 secs (Display Averaging Time is not user-selectable for Masimo®. It will be set to the default value of 8 seconds.)

NOTE: This time was measured with post average time at 8 seconds.

Low Perfusion Performance[4]:	>0.02% Pulse Amplitude %Transmission >5% Saturation (%SpO_2) ±2 digits Pulse ±3 digits
Wavelengths Emitted:	660nm and 905nm
Maximum Emitted Energy:	30mW at 50mA pulsed
Interfering Substances:	Carboxyhemoglobin may erroneously increase readings. The level of increase is approximately equal to the amount of carboxyhemoglobin present. Dyes, or any substance containing dyes, that change usual arterial pigmentation may cause erroneous readings.

Pulse Rate Performance Specifications

Pulse Rate During No Motion Conditions[1]:
Adult/Pediatric/Neonates: 26 to 239 BPM ±3 digits

Pulse Rate During Motion Conditions[2,3]:
Adult/Pediatric/Neonates: 26 to 239 BPM ±5 digits

Update Rate: Less than 4 seconds

[1]The Masimo® MS-3 Pulse Oximetry module with LNOP®•Adt sensors have been validated for no motion accuracy in human blood studies on healthy adult volunteers in induced hypoxia studies in the range of 70% to 100% SpO2 against a laboratory co-Oximetry and ECG monitor. This variation equals plus or minus one standard deviation. Plus or minus one standard deviation encompasses 68% of the population.

[2]The Masimo® MS-3 Pulse Oximetry module with LNOP®•Adt sensors has been validated for motion accuracy in human blood studies on healthy adult volunteers in induced hypoxia studies while performing rubbing and tapping motions at 2 to 4 Hz. At an amplitude of 1 to 2 cm and non-repetitive motion between 1 to 5 Hz. At an amplitude of 2 to 3 cm in induced hypoxia studies in the range of 70% to 100% SpO2 against a laboratory co-Oximetry and ECG monitor. This variation equals plus or minus one standard deviation. Plus or minus one standard deviation encompasses 68% of the population.

[3]The Masimo® MS-3 Pulse Oximetry module with LNOP®•Neo and LNOP®•NeoPt sensors has been validated for motion accuracy in human blood studies on neonates while moving the neonates foot at 2 to 4 Hz at an amplitude of 1 to 2 cm against a laboratory co-Oximetry and ECG monitor. This variation equals plus or minus one standard deviation. Plus or minus one standard deviation encompasses 68% of the population.

[4]The Masimo® MS-3 Pulse Oximetry module has been validated for low perfusion accuracy in bench top testing against a Biotek Index 2 simulator and Masimo's simulator with signal strengths of greater than 0.02% and a % transmission of greater than 5% for saturation's ranging from 70% to 100%. This variation equals plus or minus one standard deviation. Plus or minus one standard deviation encompasses 68% of the population.

[5]The LNOP®•Ear Sensors have an SpO2 accuracy of 70% to 100% ±3.5 digits for adults during no motion conditions, however, since the monitor cannot display ½ digits, the accuracy shall be rounded to ±4 digits.

[6]The SpO2 accuracy during motion conditions is not specified for the LNOP®•Ear Sensors.

2.1.9 Battery

BATTERY TYPE:	LITHIUM-ION
Number of Batteries:	1
Battery Voltage:	11.1 VDC nominal
Battery Capacity:	4.4 Amp-Hour
Battery Run Times from full charge with a new battery at 25° C with 1 NIBP measurement every 5 minutes, continuous SpO_2 monitoring, and recorder not in use.	Accutorr Plus, basic model - 9.5 hours
	Accutorr Plus, advanced models: Nellcor® - 7 hours Masimo® - 7 hours
Recharge Time:	4 hours max., in STANDBY only

2.1.10 Real-Time Clock

RESOLUTION:	1 MINUTE
Accuracy:	±1 minute/week
Display Format:	24 hours
Power:	The real-time clock maintains the time and date when the instrument is ON or in STANDBY mode, connected to AC mains, or running from the internal battery for at least ten years from original assembly. The real-time clock will maintain time and date even if the instrument's main battery is disconnected.

2.2 Safety Characteristics

2.2.1 Risk (Leakage) Currents

Enclosure Risk Current (leakage): ≤ 100*u*A in normal operating conditions
≤ 300*u*A in any single fault condition

Patient Source Current: ≤ 10*u*A in normal operating conditions
≤ 50*u*A in any single fault condition

Patient Sink Current: ≤ 50*u*A

2.2.2 Dielectric Withstand

2500V RMS at 50 or 60 Hz for 1 minute from any patient lead or combination of patient leads to the chassis.

1500V RMS at 50 or 60 Hz for 1 minute AC mains hot or neutral to the chassis.

2.2.3 Ground Resistance

Ground resistance ≤ 0.1 ohm from the AC mains power inlet module's ground contact pin to any exposed metal part, which may become energized when measured per UL 60601 and IEC 60601-1. A ground resistance of up to 0.2 ohm is allowed when measured from the U-blade of the supplied AC line cord to any exposed metal part, which may become energized.

2.2.4 Type of Protection Against Electric Shock

Class 1 with internal electric power source. Where the integrity of the external protective earth (ground) in the installation of its conductors is in doubt, the equipment is operated from its internal electric power source.

2.2.5 Degree of Protection Against Electric Shock

Monitor – Type B applied part

NIBP – Type BF defibrillation protected applied part

SpO_2 – Type BF defibrillation protected applied part

Protection Against Hazards of Explosion

Not protected (ordinary)

Protection Against Ingress of Liquids

Meets the requirements specified by IEC 60601-1, clause 44.3 and IEC 60601-2-30: Non-Protected Equipment (IPX1) as specified in EN 60529.

2.3 Physical Characteristics

Size (maximum):

Main Unit:	19 cm(W) x 26.93 cm(H) x 20.83 cm (D) 7.5" (W) x 10.6" (H) x 8.2" (D)
Recorder Module:	5.33 cm(W) x 23 cm(H) x 11 cm (D) 2.1" (W) x 9" (H) x 4.25" (D)
Predictive Module:	5.7 cm(W) x 15.9 cm(H) x 11.8 cm (D) 2.25" (W) x 6.25" (H) x 4.63" (D)
Weight:	<4.95 kg (11 pounds), depending on configuration

2.4 Environmental Characteristics

Operating

Temperature:	10°C to 40°C, 50°F to 104°F (Accutorr Plus & Recorder) 10°C to 32°C, 50°F to 90°F (Predictive Thermometer)
Humidity:	15 to 90% max, non-condensing.
Altitude:	1013 hPa to 697 hPa (0 to 10,000 ft.)
Shock and Vibration:	Meets IEC 60068-2-27 for shock with peak acceleration of 15g, 11 mSec duration, half sine. Meets EN 60068-2-64 for random vibration with frequencies of 10 to 2000 Hz, resolution of 10Hz, 10 minutes per axis, acceleration spectral density of: 10 Hz to 100 Hz : 1.0 (m/s2)2/Hz 100 Hz to 200 Hz : -3 dB per octave 200 Hz to 2000 Hz : 0.5 (m/s2)2/Hz
Shipping:	Meets ISTA Test Procedure 1A (less than 100 lbs)

Storage

Temperature:	-15°C to +60°C +5°F to 140°F
Humidity:	10 to 95%, non-condensing

2.5 Electrical Ratings

Voltage:	100 - 120 / 220 - 240 VAC
Current:	0.85 / 0.5 A
Frequency:	60 / 50 Hz
Power Consumption:	40 W, maximum

2.6 Agency Compliance

The Accutorr Plus is designed to comply with the following agency standards:

Safety, IEC	EN 60601-1:1990 +A1:1993 + A2:1995 +A13:1996 IEC 60601-1:1988 +A1:1991 +A2:1995
Safety, UL	UL 60601-1:2003
Safety, Canada	CAN/CSA C22.2 No. 601.1-M90 (R2005)
Safety, collateral	EN 60601-1-1:2001 / IEC 60601-1-1:2000
Multifunction	EN 60601-2-49:2001 / IEC 6060 1-2-49:2001
SpO2 particular	ISO 9919:2005
NIBP, particular	EN 60601-2-30:2000 / IEC 60601-2-30:1999
NIBP, IEC	EN 1060-1:1995 +A1:2002
NIBP, supplementary	EN 1060-3:1997 +A1:2005
NIBP, USA	ANSI/ AAMI SP10:2002 +A1:2003 +A2:2006
Programmable	EN 60601-1-4:1996 +A1:1999 IEC 60601-1-4:1996 +A1:1999
Temperature	ASTM E1112-00:2006
Biological	ISO 10993-1:2003
Risk	EN 14971:2000 +A3:2003
Acoustics	EN 60601-1-8:2004 +A1:2006
Random Vibe	EN 60068-2-64:1994 / IEC 60068-2-64 +corrig:1993
Shock	IEC 60068-2-27:1987
Ingress	EN 60529:1991 +A1:2001 +Corr.1:2003
Shipping	ISTA Procedure 1A:2001

Drop and Impact	ECRI PB 29689:1979
EMC	IEC 60601-1-2:2001
Magnetic Fields	EN 61000-4-8:1993 +A1:2001
Voltage Dips	EN 61000-4-11:2004
Volt Change, Fluctuations, Flicker	EN 61000-3-3:1995 +A1:2001 +A2:2005 +IS1:2005
Conducted Immunity	EN 61000-4-6:1996 +A1:2001 +A2:2006
Radiated Immunity	EN 61000-4-3:2006
ESD	EN 61000-4-2:1995 +A1:1998 +A2:2001
EFT	EN 61000-4-4:2004
Surge	EN 61000-4-5:2006
Radiated and Conducted Emissions	EN 55011:1998 +A1:1999 +A2:2002
Harmonic Emissions	EN 61000-3-2:2000 +A1:2001 +A2:2005

2.7 Electromagnetic Compatibility

The Accutorr Plus has been tested and found to comply with the requirements of IEC 60601-1-2: 2001 “Collateral Standard Electromagnetic Compatibility Requirements and Tests.”

To ensure Electromagnetic Compatibility (EMC), operate the Accutorr Plus in accordance with the instructions for use.

To prevent the possibility of other equipment affecting the Accutorr Plus, insure adequate distances are maintained between devices.

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3.0 Repair Information

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3.2 Safety Precautions 3-2
3.3 General Troubleshooting Guidelines 3-3
3.4 Test Equipment Required 3-4
3.5 Troubleshooting (Problem Isolation) 3-5
3.6 Disassembly Instructions 3-10

3.1 Introduction

This chapter of the Service Manual provides the technical information necessary to resolve most instrument malfunctions. Important prerequisites for effective troubleshooting are a thorough understanding of the instrument functions and specifications, as well as an understanding of the theory of operation. (See “Theory of Operation” on page 1-1. See “Specifications” on page 2-1.)

Functional overviews of the major circuit blocks are provided in this manual. (See “Theory of Operation” on page 1-1.) Technically qualified individuals may prefer to isolate problems to a sub-circuit or component level. Component level repair activity is not always possible. Isolation of defective components is frequently impossible without the functional emulation of operating software. The equipment and processes required are not cost-effective on a single unit basis.

The procedures detailed in this chapter are for use by qualified technical personnel only. Mindray DS USA, Inc. offers a comprehensive selection of Technical Training Seminars for this and other products. Contact the Registrar, Technical Support Department, or your regional sales or service representative for course offerings and dates.

3.2 Safety Precautions

There are areas where improper repair techniques will cause further damage. When the instrument covers are removed, observe the following precautions and guidelines.

1. Power line voltages will be exposed; identify hazard points and avoid direct contact.
2. Battery terminals are accessible; do not short to each other or the positive terminal to ground circuits, as the capacity of the battery is sufficient to create an over heating safety hazard.
3. Fuses must not be by passed or replaced by different current, voltage or time delay ratings.
4. The circuit boards contain static sensitive components; use proper static safeguard techniques.

CAUTION: Li-Ion batteries used in this device may present a risk of fire or chemical burn if mistreated. Do not disassemble, heat above 100°C (212°F), or incinerate. Replace battery with P/N: 0146-00-0069 only. Use of another battery may present a risk of fire or explosion.

CAUTION: Dispose of used battery properly. Keep away from children. Do not disassemble and do not dispose of in fire.

3.3 General Troubleshooting Guidelines

This procedure does not cover all possible problems. The intent of troubleshooting is to provide quick isolation and remedy of malfunctions and to return the instrument promptly to safe patient care. A logical approach will quickly identify the problem and suggest cost-effective solutions.

3.3.1 Troubleshooting Tips

1. Isolate the cause of the problem to be either clinical, instrument, or external. If a clinical cause is suspected, take the physiological measurement by a manual method or use an alternate measuring device. Check the physiological value against the instrument specifications; if it exceeds specification, continue with manual or alternate method.

   If a problem with the instrument is suspected, first examine and / or replace patient connected accessories. Check instrument set-up / configuration. If all set-ups are OK, replace instrument with similar device.

   If the environment is suspected, observe if the malfunction coincides with other equipment cycling (especially high-power motors, RF generators, etc.). Replace problem instrument with an identical substitute. Place the problem instrument in a low-disturbance environment. If the problem persists in the low-disturbance environment, the instrument performance may be suspect. If the substitute instrument exhibits similar poor performance in the original environment, the environmental causes must be eliminated.

2. Use the proper equipment. See “Test Equipment Required” in section 3-4 for problem isolation and resolution. Similar devices may be used if they equal or exceed performance standards of the equipment suggested.

CAUTION: Soldering and solder removal equipment must be low voltage operated and grounded to avoid static charge and stray current induced component damage. Maximum wattage: 25 W.

3. Clean the repair area. After soldering operations, clean off the repaired area with ethyl or methyl alcohol and a stiff hair brush. This will remove residual solder flux, making the repaired area more visible for an inspection and returning the instrument to its original, neat appearance. Removal of the flux will also facilitate making electrical measurements in the affected area as the flux itself is not conductive.

3.3.2 Exchange Program

A comprehensive circuit board and electro-mechanical module exchange program is available. The exchange circuits and modules are warranted, factory pre-tested and calibrated. Final calibration of the exchange item is strongly suggested to match the new part to the host system. See section 4.4 for details concerning the exchange program.

3.4 Test Equipment Required

Equipment types other than these listed may be utilized if they equal or exceed the listed equipment performance.

- Non-Invasive Blood Pressure Simulator
- Stopwatch
- SpO_2 Simulator
- RS232 Test Connector (pins 2 and 3 shorted), 9-pin male “D” and software download port tester
- Phono plug (tip and ring shorted)
- 700 cc Dummy Cuff (P/N 0138-00-0001-01)
- Chart Paper (P/N 0683-00-0447-01)
- Water Bath, stirred, heated 80° to 120° F
- Reference Thermometer, 0.1%

3.5 Troubleshooting (Problem Isolation)

This section has been divided into two major areas: clinical and technical. Clinical problems can generally be resolved by the user. Technical problems may require resolution by a qualified technical service person. The error code table below indicates Technical problems with an asterisk (*). Error codes are displayed on the front panel LEDs of the Accutorr Plus.

3.5.0.1 Error Codes

TYPE	CODE	DESCRIPTION	REASON
NIBP	8810	Retry - Unable to Measure	Motion artifact, cycle time-out, weak pulsations or no pulsations. A triple beep tone is generated.
	8811	Retry - Pump Higher	Insufficient cuff pressure. A triple beep tone is generated.
	8812	Stop - Cuff Overpressure	Excessive cuff pressure detected by the software. A triple beep tone is generated.
	8813	Stop - Unable to Measure	4 successive measurement attempts failed. A triple beep tone is generated.
TEMP (PTM)	8830	Check Probe	Tissue contact may have been lost.
	8831	Replace Probe	Defective probe or connection.
SpO_2	8850	No Sensor	No sensor connected.
	8851	Sensor Off	Sensor not on patient. (Masimo® SpO_2 only)
	8852	Interference	Interference on signal. (Masimo® SpO_2 only)
	8853	Pulse Search	Unit cannot find signal. (Nellcor® SpO_2 module will report “Pulse Search" -8853- when the sensor is not on the patient.)
	8854	Weak Pulse	Weak pulse detected. (Masimo® SpO_2 only)
	8856	Check Sensor	Sensor problem. (Masimo® SpO_2 only)
	8857	PR<21	Pulse rate is less than 21 bpm. (Nellcor® SpO_2 only)
	8857	PR<26	Pulse rate is less than 26 bpm. (Masimo® SpO_2 only)
	8858	PR>249	Pulse rate is greater than 249 bpm. (Nellcor® SpO_2 only)
	8858	PR>239	Pulse rate is greater than 239 bpm. (Masimo® SpO_2 only)

TYPE	CODE	DESCRIPTION	REASON
SYSTEM	984*	NIBP Hardware Failure	NIBP A/D failure detected.
	985*	NIBP Overpressure Circuit not Programmed	The overpressure circuit is not set to the current patient size.
	986*	NIBP Overpressure Circuit not Tracking	The two pressure transducers are not tracking each other.
	987*	Stop - Hardware Overpressure	Excessive cuff pressure detected by hardware overpressure sensor. A triple beep tone is generated.
	988*	TEMP Bad Calibration	Thermometer needs calibration.
	990*	TEMP Illegal Mode	Thermometer switch is set wrong.
	991*	TEMP Module Failed	Thermometer internal failure.
	995*	SpO_2 Uncalibrated	SpO_2 fails calibration check.
	996*	SpO_2 Failure	SpO_2 failed self-test.

3.5.1 Isolating the Problem, System Level

1. Determine if the problem is in the main NIBP unit or in one of the add-on accessories.
2. If the problem is in the accessory, check the recorder unit for correct paper, correct installation, and paper jams.
3. If the problem is in the main NIBP and/or SpO_2 section, rule out these simple problems first:

   If AC power is available, then the green LED adjacent to the front panel **ON/STANDBY** keys should be illuminated. If not, connect the power cord to a live power outlet. If the green LED fails to illuminate, there is a probable power supply malfunction.

   Check the battery operation LED. Steady ON indicates battery operation. A flashing LED indicates a near depleted battery. If the green LED is NOT illuminated, then the battery or power supply/charger may be suspect.

   Confirm correct operating parameters selection (i.e., correct patient size selection, (Adult, Neonate, Ped.) and NIBP cuffs to match. In units with SpO_2, verify that a sensor is connected to the unit and it is of the proper type/size.

3.5.2 Isolating the Problem within the Main Unit

Problems within the main NIBP and/or SpO_2 unit are categorized broadly into power supply problems and NIBP and/or SpO_2 detection and display. For a monitor that will not even turn on, proceed to Power Supply and Battery Tests, otherwise skip to Diagnostics Test and beyond.

1. Power Supply and Battery test: The main power supply output voltages should be verified under normal instrument loads. Below are the tolerances for the voltages shown:

   5V = 4.9 - 5.1
   12.5V = 12 - 13
   ±15V = 14.5 - 15.5

2. Perform Diagnostics Test 01 through 12. Repair or replace circuits or components that fail the Diagnostic Test.
3. Trend circuits test: Obtain a minimum of five NIBP measurements and simultaneous SpO_2 and Temperature readings if the Accutorr has those options. Confirm Trend storage function as explained in the operating instructions.

3.5.3 Isolating the Problems with Optional Accessory Modules

1. Predictive Temperature Module Test: Obtain one or more temperature readings from the optional temperature modules. They will be displayed in the temperature display window. If the readings are not displayed, replace the temperature probe first, then the complete module.
2. Recorder Module Test: Obtain a print out of stored data, or perform diagnostics test (#4) to verify recorder integrity. Substitute recorder with a known good device to confirm diagnosis.
3. Infrared (AccuTemp IR) temperature module test: The following paragraphs will assist you to separate those clinical issues that can result in inaccurate or inconsistent readings, as well as instrument malfunctions.

   Since there are no user serviceable components (except 9V battery) inside the AccuTemp IR, all service requests should be directed to the factory.

3.5.4 Clinical Issues with AccuTemp IR Ear Thermometer Applications

3.5.4.1 Multiple Temperature Measurements

The AccuTemp IR employs an easy and quick method to taking temperature measurements. Because of this, it is tempting to take immediate repetitive measurements. However, taking immediate repetitive measurements in the same ear may result in a decrease in temperature. This is because the probe of an ear thermometer is cooler than the ear canal and will draw the heat from the ear canal, cooling the canal slightly. Waiting a few minutes before taking another temperature in the same ear will give the ear canal time to recover, and the readings should be consistent with the initial measurement.

3.5.4.2 How the AccuTemp IR Measures Arterial Temperature (Adults/ Pediatrics)

The AccuTemp IR is a self-calibrating infrared ear thermometer that accurately measures the infrared heat energy radiating from the ear canal opening. The AccuTemp IR determines the highest temperature in the ear canal opening, measures the ambient temperature, and then calculates arterial (core) temperature through its patented heat balance system. This measurement will respond instantly to changes in arterial temperature without the delays and artifacts inherent in oral and rectal methods, providing the means to identify a fever faster and more reliably than other methods.

Temperature gradients in the ear canal vary with the amount of environmental exposure, perfusion patterns, ambient temperature, etc. The least variable and therefore most accurate is the small deep area of warmest, but still visible tissue. A conventional ear thermometer takes many readings of the same large area, which includes the high gradient distal ear tissue, resulting in low, non-reproducible, and inaccurate temperature readings. The AccuTemp IR utilizes a narrow field-of-view and scanning capability to search the ear for the small deep area of warmest tissue required for heat balance calculation to ensure highly accurate and reproducible arterial temperatures.

The temperature measurement will remain on the display for a minimum of 55 and a maximum of 65 seconds after the Start button is released. If using the AccuTemp IR with and Accutorr Plus, the temperature measurement can be transferred from the AccuTemp IR to the Accutorr Plus for display and entry in to the trend database, by placing the AccuTemp IR in its holder within the 60 seconds after releasing the Start button. A beep tone is sounded from the Accutorr Plus once the temperature measurement information has been received by the Accutorr Plus.

NOTE: Do not change Room Number and /or Bed Letter on the Accutorr Plus during the transmission of temperature data.

The AccuTemp IR can be used to take temperature measurements for up to 128 power cycles without having to be put back into its holder. After 128 power cycles, the AccuTemp IR must be put back into the holder to be reset. When the 129th power cycle is reached and the Start button is pressed, 4 L's are displayed, indicating that the AccuTemp IR is locked and must be returned to its holder.

NOTE: The AccuTemp IR thermometer should be at room temperature when it is used. If it has been in a very warm or very cold environment it may need time for the thermometer temperature to equalize to ambient temperature.

3.5.4.3 Troubleshooting

The following table provides suggestions to resolve problems when taking temperature measurements:

SYMPTOM	SUGGESTION
Various readings when taking measurements in the same location, ear or axilla.	Quick repetitive measurements in the same location can result in a decrease in temperature. This can occur because the optical head of AccuTemp IR may slightly cool the area. Wait a few minutes for the temperature of the area to equilibrate. Replace cover and clean lens with an alcohol swab.
Various readings when taking measurements in opposite ears.	The patient may by lying down on one ear. The measurement of the ear that was down may be a higher temperature. Wait a few minutes for the temperature of the ear canal to equilibrate or use opposite ear. This is also a factor if the area has been covered for any reason (for example, with a hat, blanket, bandage, telephone, etc.).
No measurement or inaccurate measurements.	This can be caused by technique errors:-Not keeping the button pressed throughout the measurement.-Not scanning side-to-side (adults and pediatrics).-Twisting or rotating the probe instead of scanning side-to side.-Not changing the protective optical film cover with each reading. (Even on the same patient.)-Debris on the lens.-Not covering the opening of the ear canal.-Presence of a visible wax plug, or dense hair blocking the view into the ear canal.-This can also be caused by low battery voltage.

ACCUTEMP IR ERROR	REASON
AccuTemp IR double beeps and displays "——" while holding the Start button. The AccuTemp IR then powers down.	Battery voltage < 5.7 VDC. Battery requires replacement.
AccuTemp IR double beeps while holding the Start button	Low battery condition. Battery voltage is between 6.2 and 5.7 VDC.
AccuTemp IR displays "E-O0"or "E-o1" while holding the Start button.	Return AccuTemp IR for service.

3.5.4.4 Maintenance

The AccuTemp IR can be wiped down with any hospital approved disinfectant, including bleach. With normal use, the only maintenance required is to keep the lens on the end of the probe clean. The lens is made of polycarbonate. Dirt, greasy films or moisture on the lens will interfere with the passage of infrared heat and affect the accuracy of the measurement. If necessary, clean the lens with a cotton swab dipped in alcohol. Periodic cleaning is recommended. To keep the lens clean when not is use, store the AccuTemp IR with an optical film cover in place.

3.6 Disassembly Instructions

CAUTION: The Inside Of This Instrument Contains Static Sensitive Components. Use correct static protection safeguards.

1. Power down the Accutorr Plus and remove the AC power cable.
2. Remove all cables and hoses from the front and rear of the instrument.
3. Remove temperature measuring module and recorder module, if equipped.

3.6.1 Removal of the Rear Housing

1. Place the Accutorr Plus with the display side down, onto a protective surface.

NOTE: Special care should be taken to insure that the front panel and glare screen are not scratched.

2. Remove the 4 screws from the corners of the back housing recess and the two screws in the center channel of the rear case.
3. Slowly lift the rear housing up and place in a safe location.
4. Disconnect battery connector (J4) from the Power Supply board.

3.6.2 Removal of the Front Bezel

1. Place the front housing with the display side down, onto a protective surface.
2. Disconnect the SpO_2 ribbon cable (J3) from the SpO_2 circuit board and the tubing from the NIBP front panel connector.
3. Slowly separate the assembly up and away from the front housing.

3.6.3 Removal of the Keyboard Assembly

1. Place the instrument with the display side down, onto a protective surface.
2. Remove the Front Bezel, as described above.
3. Remove the screws (6) securing the Keyboard Assembly and lift the keyboard, supporting and separating the connector to the LED/Tone board.

3.6.4 Removal of the LED/Tone board

1. Remove front bezel and keyboard.
2. Disconnect cable from J4, the speaker connection.
3. Remove the four screws holding the circuit board. Pull circuit board forward, disconnecting the rear J-1 connector.

3.6.5 Removal of the CPU / NIBP board

1. Disconnect J-505 NIBP pump connector, J-7 SpO_2 interface connector (advanced model), and J-502 Power supply connector, all on the top edge of the board.
2. Disengage the captive cable connectors for the Recorder and Temperature options at the bottom left and right edges of the board.
3. Disconnect gray ribbon cable at J-603 to the external interface connectors.
4. Disconnect J-651 the LED backlight connector (advanced model).
5. Disconnect silicon hose from pump, at the right angle elbow.
6. Remove the four hexagonal spacers and one Phillips head screw on the board.
7. Lift board up gently and disconnect data ribbon cable from J-8 to the LCD display (advanced model).

3.6.6 Removal of the Power Supply Assembly

1. Remove AC mains power cord and internal battery. Remove rear case.
2. Disconnect ribbon cable at J-3 on the power supply. Disconnect battery J-4 connector cable. Disconnect input cable at J-2.
3. Remove screws as shown in Figure 3-1.

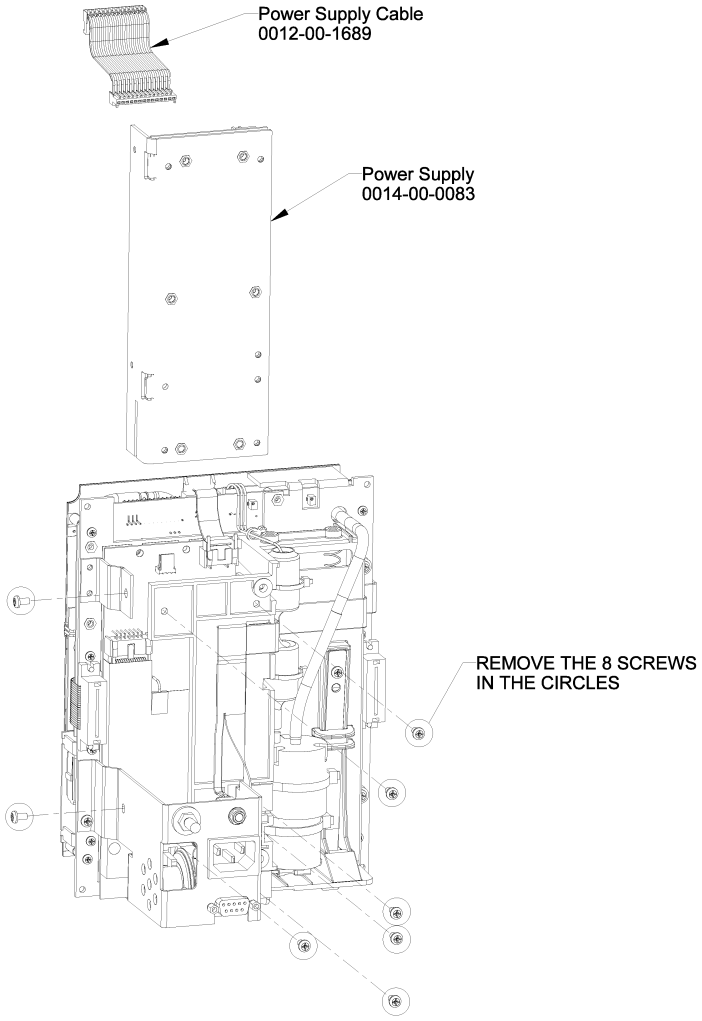


FIGURE 3-1 Power Supply Assembly Diagram

3.6.7 Removal of the LCD Display (Advanced Model)

1. Remove the right side support bracket for the LCD. Disconnect data ribbon cable.
2. Disengage LCD circuit board from left side support bracket and disconnect backlight cable from the CPU / NIBP board.

3.6.8 Removal and replacement of the Internal Li-Ion Battery

To remove the externally accessible battery, press the quick release tab on the battery access door and open door. The battery is retained internally in a sliding compartment, captured by a spring loaded release tab. Press the tab away from the battery; the battery will eject with a spring assist mechanism.

Reverse the process to install the replacement battery.

NOTE: New batteries are shipped in a discharged state for safety reasons. A new battery must be charged for 4 hours for Li-Ion before first use. The monitor may be used with AC mains power during the charge cycle but battery operation could be limited during this time.

3.6.9 Removal of the AC Input Receptacle Assembly

1. Press the plastic locking tabs on the rear of the AC receptacle. A small screwdriver may be inserted at the cut out on the left of the AC connector, to release the locking tabs.
2. From the front side of the receptacle, starting at the edge closest to the Interface connector, press upwards, while pulling the connector out.
3. Disconnect the cable end from the Power Supply circuit board.
4. Remove the locking nuts from the safety ground terminal stud; remove ground conductor.

3.6.10 Thermal Printer (optional module)

1. Detach the complete module from the main NIBP section, by removing the two screws in the plastic housing. Grasp the plastic housing and pull to the rear to disengage the Interface connector.
2. Remove the two screws retaining the circuit board and the anti static shield assembly. Remove the shield.
3. Remove the remaining two screws and lift the circuit board out.

3.6.11 Thermometer, Predictive (optional module)

1. Detach the complete module from the main NIBP section by removing the two screws in the plastic housing. Grasp the plastic housing and pull to the rear to disengage the interface connector.

2. Remove J2 and J3 connectors from the circuit board to front panel input receptacle.

NOTE: The connectors may be reversed or interchanged without affecting final function.

3. Remove the three screws securing the circuit board and anti static shield. Remove the assembly.

3.6.12 AccuTemp IR, Infrared Thermometer (optional module)

The AccuTemp IR has no user accessible adjustments or replaceable parts, except for the 9 Volt battery. If problems arise, contact Technical Service.

3.6.13 AccuTemp IR Mounting Cradle

The mounting cradle has no adjustments or replaceable parts. The mounting cradle houses a small circuit board and a photocell sensor.

3.7 Interconnect Cables Run List

3.7.1 Interface Specifications, Connectors and Functions.

3.7.1.1 Connector to LED / Tone PCB, J-2

PIN #	INPUT/OUTPUT	DESCRIPTION	NAME
1		Vcc return	D(digital ground)
2	Output	Reset	RST_CONN*
3	Input/Output	Damped Data Bus D(0)	D_DAMP_CONN(0)
4	Input	Write Recorder	WR_RECD*
5		Vcc return	D(digital ground)
6		FPGA Not Done	FPGA_NOT DONE*
7	Input/Output	Damped Data Bus D(1)	D_DAMP_CONN(1)
8	Output	Read/ Write	R/W_CONN*
9		Vcc return	D(digital ground)
10	Output	LDS	LDS*
11	Input/Output	Damped Data Bus D(2)	D_DAMP_CONN(2)
12	Output	Chip Select I/O	CS_IO*
13		Vcc return	D(digital ground)
14	Input	Write Delay	WR_DLY*
15	Input/Output	Damped Data Bus D(3)	D_DAMP_CONN(3)
16	Input	ST Watchdog	ST_WDOG*
17		Vcc return	D(digital ground)
18	Input	LCD Angle	LCD_ANGLE
19	Input/Output	Damped Data Bus D(4)	D_DAMP_CONN(4)
20	Input	LCD Angle Feed Back	LCD_ANGLE_FB
21		Vcc return	D(digital ground)
22	Input	LCD Angle Reference	LCD_REF
23	Input/Output	Damped Data Bus D(5)	D_DAMP_CONN(5)
24	Output	TONE	TONE
25		Vcc return	D(digital ground)
26	N/C	N/C	N/C
27	Input/Output	Damped Data Bus D(6)	D_DAMP_CONN(6)
28	Input	Read Configure	RE_CONFG*
29		Vcc return	D(digital ground)
30	N/C	N/C	N/C
31	Input/Output	Damped Data Bus D(7)	D_DAMP_CONN(7)
32		+5V Supply	VCC
33		Vcc return	D(digital ground)
34		+5V Supply	VCC

PIN #	INPUT/OUTPUT	DESCRIPTION	NAME
35	Input/Output	Damped Data Bus D(8)	D_DAMP_CONN(8)
36	N/C	N/C	N/C
37		Vcc return	D(digital ground)
38		+5V Supply	VCC
39	Output	Clock O	CLKO_CONN
40		+5V Supply	VCC
41		Vcc return	D(digital ground)
42	Input	Keypad Data Bus (D0)	KEYD0
43	Output	Damped Address(2)	A_DAMP_CONN(2)
44	N/C	N/C	N/C
45		Vcc return	D(digital ground)
46	N/C	N/C	N/C
47	Output	Damped Address(3)	A_DAMP_CONN(3)
48	Input	Keypad Data Bus (D3)	KEYD3
49		Vcc return	D(digital ground)
50	N/C	N/C	N/C
51	Output	Damped Address(4)	A_DAMP_CONN(4)
52	N/C	N/C	N/C
53		Vcc return	D(digital ground)
54	N/C	N/C	N/C
55	Output	Damped Address(5)	A_DAMP_CONN(5)
56	N/C	N/C	N/C
57		Vcc return	D(digital ground)
58	Output	AC ON	ACON*
59	Output	Damped Address(6)	A_DAMP_CONN(6)
60	Input	Switched ON/OFF	ON/OFFSW*
61		Vcc return	D(digital ground)
62	N/C	N/C	N/C
63	Output	Damped Address(7)	A_DAMP_CONN(7)
64	N/C	N/C	N/C
65	Output	Vcc return	D(digital ground)
66	N/C	N/C	N/C
67	N/C	N/C	N/C
68	Output	AC LED ON	ACON_LED
69		+5V Supply	VCC
70	Input	High Low	HIGH/LOW*
71		+5V Supply	VCC
72	Input	LCD Unit	LCD_UNIT*
73	N/C	N/C	N/C
74	N/C	N/C	N/C

PIN #	INPUT/OUTPUT	DESCRIPTION	NAME
75		SpO_2 RESET	SpO2RST*
76		+12V -15V ON	+12V -15V ON
77		CHARGE OFF	CHRGOFF
78	N/C	N/C	N/C
79	Output	A/D Chip Select	ADC_CS*
80		PWM CONTROL	PWM_CNTRL

3.7.1.2 Power Supply Header, J-502

PIN #	DESCRIPTION	NAME
1	+5V Supply	+5V
2	+5V Supply	+5V
3	+5V Return	D(Digital Ground)
4	+5V Return	D(Digital Ground)
5	+15V Supply	+15V
6	-15V Supply	-15V
7	+/- 15V Return	A(Analog Ground)
8	+12V Return	P(Power Ground)
9	+12V Supply	+12V
10	Standby	STDBY
11	AC ON	ACON*
12	+12V -15V ON	12+-15ON*
13	OFF/ON	OFF/ON*
14	Charge Off	CHRGOFF*

3.7.1.3 J-2 Keypad Connector

PIN #	FUNCTION	PIN #	FUNCTION
1	Battery LED	16	Key D7
2	Interval LED	17	Key D6
3	Neonatal LED	18	Key D5
4	Pediatric LED	19	Key D4
5	Adult LED	20	Key D3
6	Memory Full LED	21	Key D2
7	NIBP Ready LED	22	Key D1
8	Print LED	23	Key D0
9	Mute LED	24	On/Off Sw*
10	Data Scan LED	25	Ground
11	AC On LED	26	LED_EN0

PIN #	FUNCTION	PIN #	FUNCTION
12	AC On*	27	High_Low*
13	Key 2	28	LCD_Unit*
14	Key 1	29	LED_EN1
15	Key 0	30	LED_EN2

3.7.1.4 J-4 Speaker Connector

PIN #	FUNCTION
1	Speaker terminal
2	Speaker terminal
3	no connection

3.7.1.5 Recorder Connector, J-5

PIN #	INPUT/OUTPUT	DESCRIPTION	NAME
1	Output	TTL, recorder data	Buffered Data Bus, DX<7>
2	Output	TTL, recorder data	Buffered Data Bus, DX<6>
3	Output	TTL, recorder data	Buffered Data Bus, DX<5>
4	Output	TTL, recorder data	Buffered Data Bus, DX<4>
5	Output	TTL, recorder data	Buffered Data Bus, DX<3>
6	Output	TTL, recorder data	Buffered Data Bus, DX<2>
7	Output	TTL, recorder data	Buffered Data Bus, DX<1>
8	Output	TTL, recorder data	Buffered Data Bus, DX<0>
9	Output	ground	DGND
10	Output	TTL, recorder write	WR_RECD*
11	Input	logic low: Recorder module attached	RECD*
12	Output	TTL, Reset recorder	RESETSRV*
13	Output	TTL, Recorder home	HOME*
14	Output	TTL, Run print head	RUN*
15	Input	TTL, DMA request	DREQ*
16	Output	+5V supply (+/-2%)	VCC
17	Output	+5V printer supply (+/-1V)	+5V
18	Output	+5V return	PGND
19	Output	+5V printer supply (+/-1V)	+5V
20	Output	+5V return	PGND

3.7.1.6 Thermometer Connector, J-4

PIN #	INPUT/OUTPUT	DESCRIPTION	NAME
1	Input	TTL, serial in	TEMP_TXD
2	Input	TTL, serial in	TEMP_TXD
3	Output	ground	DGND
4	Output	ground	DGND
5	Output	TTL, serial out	TEMP_RXD
6	Output	TTL, serial out	TEMP_RXD
7	N/C	N/C	N/C
8	N/C	N/C	N/C
9	N/C	N/C	N/C
10	N/C	N/C	N/C
11	Output	9 - 17.3 VDC	STDBY
12	Output	ground	aground
13	Output	+5VDC +/- 2% supply	VCC
14	Output		VCC
15	Input	logic low: 0.8V max Predictive Temp module attached	PRED*
16	Input		PRED*
17	Output	ground	DGND
18	Input	logic low: 0.8V max SpO_2 option 2 installed	SpO2_OPT2*
19	Input	logic low: 0.8V max IR Temp module attached	TYMP*
20	Input	logic low: 0.8V max SpO_2 option installed	SpO2_OPT1*

3.7.1.7 SpO_2 Connector, J-7

PIN #	INPUT/OUTPUT	DESCRIPTION	NAME
1	Output	ground	DGND
2	Output	TTL, module reset	SpO2RST*
3	Output	ground	DGND
4	Output	TTL, serial out	SpO2_RX
5	Input	SpO_2 module installed: logic low @ 0.8V max	SpO2*
6	Input	TTL, serial in	SpO2_TX
7	Output	+5V supply (+/-5%)	+5V
8	Output	-15V supply (+/-5%)	-15V
9	Output	Analog ground	AGND
10	Output	+15V supply (+/-5%)	+15V

3.7.1.8 NIBP Pump Connector, J-505

LED

PIN #	INPUT/OUTPUT	DESCRIPTION	NAME
1	Output	pump supply	+12VF
2	Input	pump return	PUMP*
3	Input	power ground	P(power ground)

3.7.1.9 LED Backlight Connector, J-651

PIN #	INPUT/OUTPUT	DESCRIPTION	NAME
1	Output	Min 3.4V - Max 3.6V	BL+
2	Input	Return	BL-

3.7.1.10 Communication Connector, J-603

PIN #	INPUT/OUTPUT	DESCRIPTION	NAME
1	N/C	N/C	N/C
2	Input	RS-232	RTS
3	Output	RS-232	CTS
4	Output	Ground	DGND
5	N/C	N/C	N/C
6	Output	Ground	DGND
7	Output	RS-232, Transmit	EXT_TXD
8	Input	RS-232, Receive	EXT_TXD
9	Output	Ground	DGND
10	Output	Ground	DGND
11	Output	+7Vdc min	NCall
12	Output	RS-232 or RS-485	TXD
13	Input	RS-232 or RS-485	RXD
14	Output	12VDC +/- 5%@ 100mA	+12VT

3.7.1.11 LCD Connector, J-8

PIN #	INPUT/OUTPUT	DESCRIPTION	NAME
1	Out	Chassis Ground	CHASSIS
2	Out	ground	DGND
3	Out	+5V supply (+/-5%)	VCC
4	Out	View angle control -15V max	VEE
5	Out	TTL, control line	WR_LCD*
6	Out	TTL, control line	RD_LCD*

PIN #	INPUT/OUTPUT	DESCRIPTION	NAME
7	Out	TTL, control line	CS_LCD*
8	Out	TTL, address line	A_DAMP_CONN<2>
9	In	-10V supply	-10V
10	Out	TTL, LCD reset	RESETSRV*
11	In/Out	TTL, data line	D_DAMP_CONN<0>
12	In/Out	TTL, data line	D_DAMP_CONN<1>
13	In/Out	TTL, data line	D_DAMP_CONN<2>
14	In/Out	TTL, data line	D_DAMP_CONN<3>
15	In/Out	TTL, data line	D_DAMP_CONN<4>
16	In/Out	TTL, data line	D_DAMP_CONN<5>
17	In/Out	TTL, data line	D_DAMP_CONN<6>
18	In/Out	TTL, data line	D_DAMP_CONN<7>
19	Out	ground	DGND
20	N/C	N/C	N/C
21	Out	TTL Level	A_DAMP_CONN<3>
22	Out	TTL Level	A_DAMP_CONN<4>
23	Out	TTL Level	DSP_CONT*
24	Out	TTL Level	A_DAMP_CONN<5>
25	Out	+15VDC	+15VV
26	Out	-15VDC	-15VV

3.7.2 Power Supply Connectors

3.7.2.1 AC input connector, J-2

PIN #	FUNCTION	PIN #	FUNCTION
1	AC Ground	4	N/C (pin removed)
2	N/C (pin removed)	5	AC Hot
3	AC Neutral		

3.7.2.2 DC output connector, J-3

PIN #	FUNCTION	PIN #	FUNCTION
1	+5 V	8	Common
2	+5 V	9	+12.5 V
3	Common	10	STDBY
4	Common	11	ACON*
5	+15 V	12	+12-15ON*

PIN #	FUNCTION	PIN #	FUNCTION
6	-15 V	13	OFF/ON*
7	Common	14	CHRGOFF*

3.7.2.3 Battery connector, J-4

Connector Pin Out

PIN #	CONNECTION
1	TS (temperature sense)
2	Battery +11.1 V
3	Common

4.0 Replacement Parts and Isometric Drawings

4.1 Introduction 4-1
4.2 Available Replacement Parts And Sub-Assemblies 4-1
4.3 Product Variations And Options 4-1
4.4 Exchange Program 4-2
4.5 Replacement Parts Pricing Information 4-2
4.6 Ordering Information 4-2
4.7 Isometric Drawings and Parts Lists 4-3
4.8 Accessory Modules and Mounting Parts Lists 4-10

4.1 Introduction

This chapter of the Service Manual provides information necessary to identify the replacement parts and assemblies of the instrument.

4.2 Available Replacement Parts And Sub-Assemblies

The parts listings which follow are divided into two sections. The Isometric Drawings and the accompanying parts lists identify the available chassis mounted components.

4.3 Product Variations And Options

Product variations, due to differences for various line voltages, options and languages may require different components. These variations are reflected, where necessary, on the parts lists.

4.4 Exchange Program

An exchange policy for most of the printed circuit board assemblies is available. This program may provide the most expedient method of servicing the equipment. A standard charge for this service is made. Contact the Service Department for details concerning this exchange program.

Many circuit boards make extensive use of multi-layer technology and high density packaging. Individual component replacement is not recommended on these boards unless the technician is properly equipped to repair multi-layer circuit boards.

Circuit boards, returned as parts of the exchange program, that show evidence of improper repair techniques and are damaged in the process are not considered for exchange. Damaged boards will be invoiced at full value and no exchange credit will be applied.

4.5 Replacement Parts Pricing Information

Current parts prices and exchange charges can be determined by contacting the Order Entry Department.

4.6 Ordering Information

Replacement parts and assemblies are available from Mindray DS USA, Inc. Please follow these guidelines when ordering replacement items for the instrument.

1. Include the Model and Serial Number of the instrument. (The model number of the Accutorr Plus starts with the numbers “0998-” and consists of 13 or 14 digits. All digits must be supplied.)
2. Include the Part Number exactly as it appears in the Parts List under the column, “Part Number.”
3. Include a description of the item.

Example Orders:

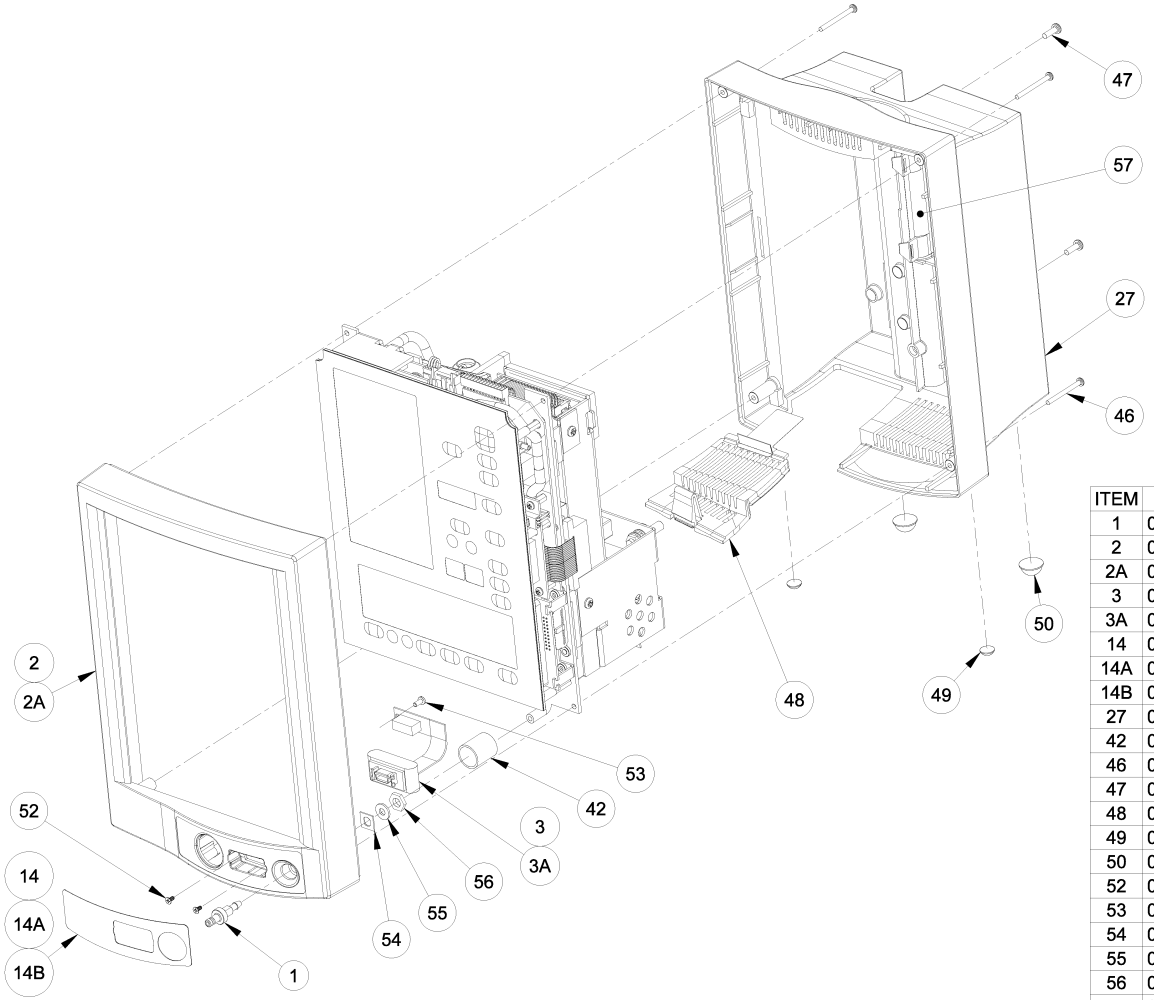
(1) ea. P/N 0014-00-0083-02
Main Power Supply Board
Serial No. XXXX-XX

(2) ea. P/N 0212-12-0404
Screw, #4-40 x .25 lg. Pan Head,
Serial No. XXXX-XX

NOTE: Mindray DS USA, Inc. maintains a policy of continuous development for product improvement and reserves the right to change materials, specifications, and prices without notice.

4.7 Isometric Drawings and Parts Lists

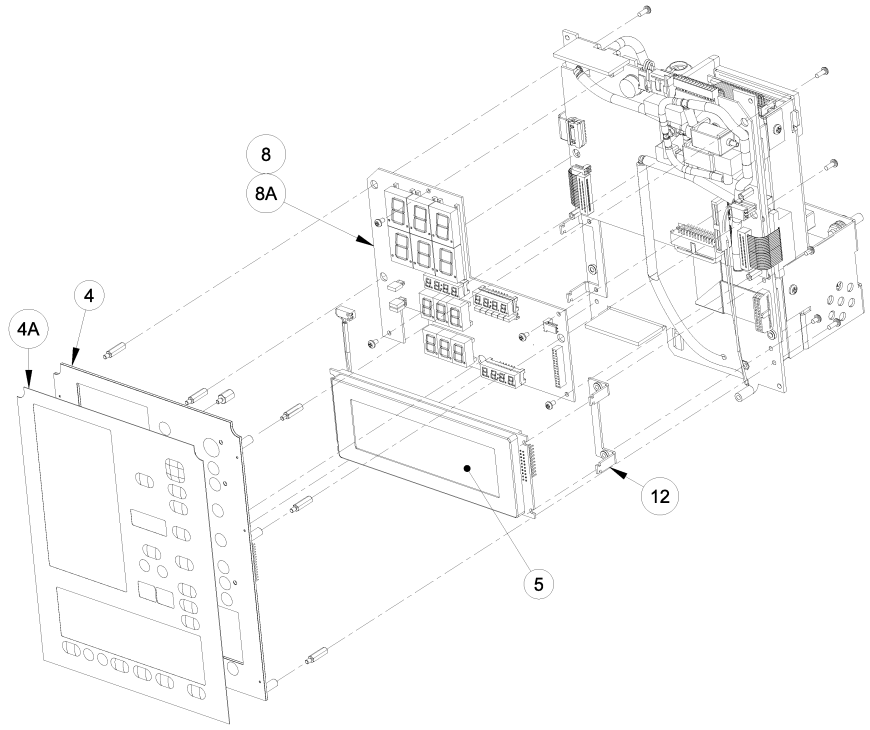
The following figures show exploded views of the Accutorr Plus components, part numbers, and descriptions.



ITEM	PART NUMBER	DESCRIPTION
1	0103-00-0411	NIBP Connector
2	0380-00-0359-06	Bezel, w/ Masimo SpO2 or w/o SpO2
2A	0380-00-0359-08	Bezel, w/ Nellcor SpO2
3	0012-00-1463	SpO2 Connector Assembly, Nellcor
3A	0012-00-1344	SpO2 Connector Assembly, Masimo
14	0334-00-1509-01	Label, Bezel, without SpO2
14A	0334-00-1509-05	Label, Bezel, with Nellcor SpO2
14B	0334-00-1509-04	Label, Bezel, with Masimo SpO2
27	0380-00-0357-03	Rear Housing, complete w/ Rear Cover Cap
42	0008-00-0324	Insulator Tube, PVC, .75"
46	0212-12-0420	Screw, Rear Housing, 4-40 x 1.25"
47	0212-12-0608	Screw, Rear Housing, 6-32 x .500"
48	0380-00-0358-02	Battery Door w/ Plastic Hinge
49	0348-00-0191-01	Rubber Feet, Small
50	0348-00-0191-02	Rubber Feet, Large
52	0211-00-0140	Screw, SpO2 Connector, Bezel
53	0212-10-0404	Screw, Masimo SpO2 Connector
54	0386-00-0162	Luer Plate
55	0210-09-0025	Lock Washer
56	0220-00-0004	Hex Nut
57	0380-00-0547	Cap, Rear Cover

FIGURE 4-1

ITEM	PART NUMBER	DESCRIPTION
4	See Keypad Selection Table	Keypad
4A	See Keypad Selection Table	Graphic Overlay
5	0160-00-0101	LCD Display
8	0670-00-0815-01	LED/Tone PCB with SpO2
8A	0670-00-0815-02	LED/Tone PCB without SpO2
12	0406-00-0884	Bracket, LCD



Keypad Selection Table *			
Monitor Configuration	Monitor Part Number 0998-00-0444-	Keypad Part Number	Graphic Overlay Part Number
NIBP only English	-91A	0331-00-0116-01	0330-00-0025-01
NIBP Nellcor SpO2 English	-93A	0331-00-0116-04	0330-00-0027-01
NIBP Masimo SpO2 English	-94A	0331-00-0116-04	0330-00-0027-01
NIBP only German	-91G	0331-00-0116-01	0330-00-0025-02
NIBP Nellcor SpO2 German	-93G	0331-00-0116-04	0330-00-0027-02
NIBP Masimo SpO2 German	-94G	0331-00-0116-04	0330-00-0027-02
NIBP only Spanish	-91P	0331-00-0116-01	0330-00-0025-03
NIBP Nellcor SpO2 Spanish	-93P	0331-00-0116-04	0330-00-0027-03
NIBP Masimo SpO2 Spanish	-94P	0331-00-0116-04	0330-00-0027-03
NIBP only French	-91F	0331-00-0116-01	0330-00-0025-04
NIBP Nellcor SpO2 French	-93F	0331-00-0116-04	0330-00-0027-04
NIBP Masimo SpO2 French	-94F	0331-00-0116-04	0330-00-0027-04
NIBP only Italian	-91T	0331-00-0116-01	0330-00-0025-06
NIBP Nellcor SpO2 Italian	-93T	0331-00-0116-04	0330-00-0027-06
NIBP Masimo SpO2 Italian	-94T	0331-00-0116-04	0330-00-0027-06

* Must replace Keypad and Graphic Overlay at the same time.

FIGURE 4-2

ITEM	PART NUMBER	DESCRIPTION
7	0012-00-1721	Cable, LCD Interface
9	0012-00-1690	Cable, SpO2 to CPU/NIBP Interface
28	0012-00-1689	Cable, Power Supply to CPU/NIBP Interface
30	0670-00-0814-01	PCB, CPU/NIBP
31	0014-00-0083-02	Power Supply (Li-Ion)

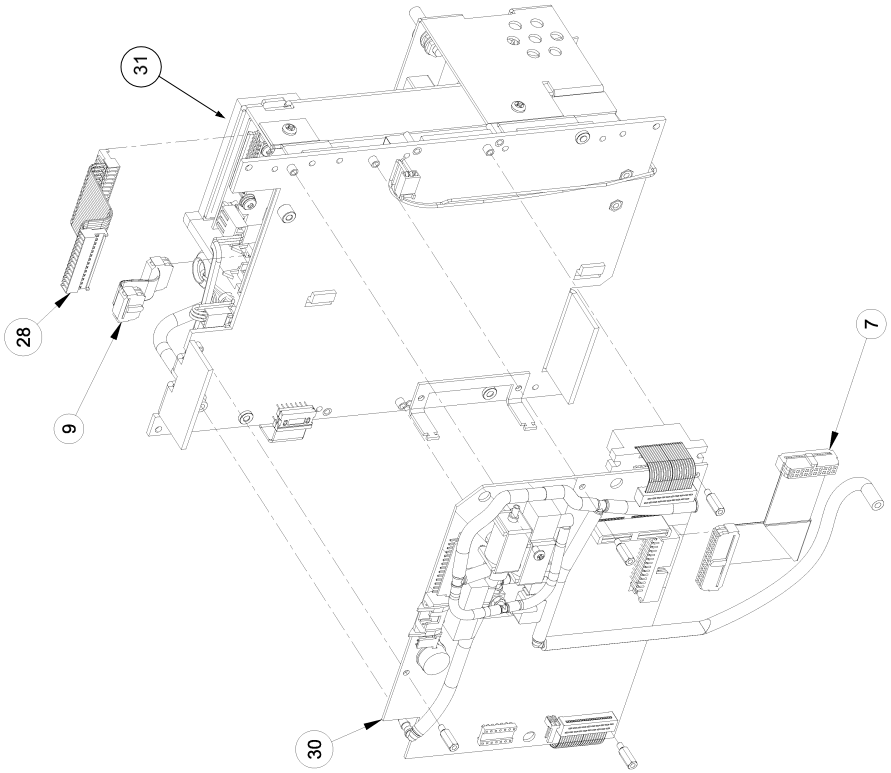


FIGURE 4-3

ITEM	PART NUMBER	DESCRIPTION
15	0997-00-0595	Assembly, Chassis
38	0344-00-0249	Push Fastener, Plastic
39	0012-00-1338	Cable, MS-3 Interface
40A	0671-00-0066	PCB, Nellcor SpO2 (OEM)
40B	0670-00-0740	PCB, Nellcor SpO2 Interface
40C	0671-00-0055	PCB, Masimo SpO2 (OEM)
40D	0670-00-0716	PCB, Masimo SpO2 Interface
43	0217-00-0047	Screw, Captive Panel
44	0221-00-1026	Washer, Shoulder .145" OD, .115" ID
45	0221-00-1018	Washer, Shoulder .185" OD, .116" ID
53	0212-10-0404	Screw, Mach, Round Head, Slotted, Nylon

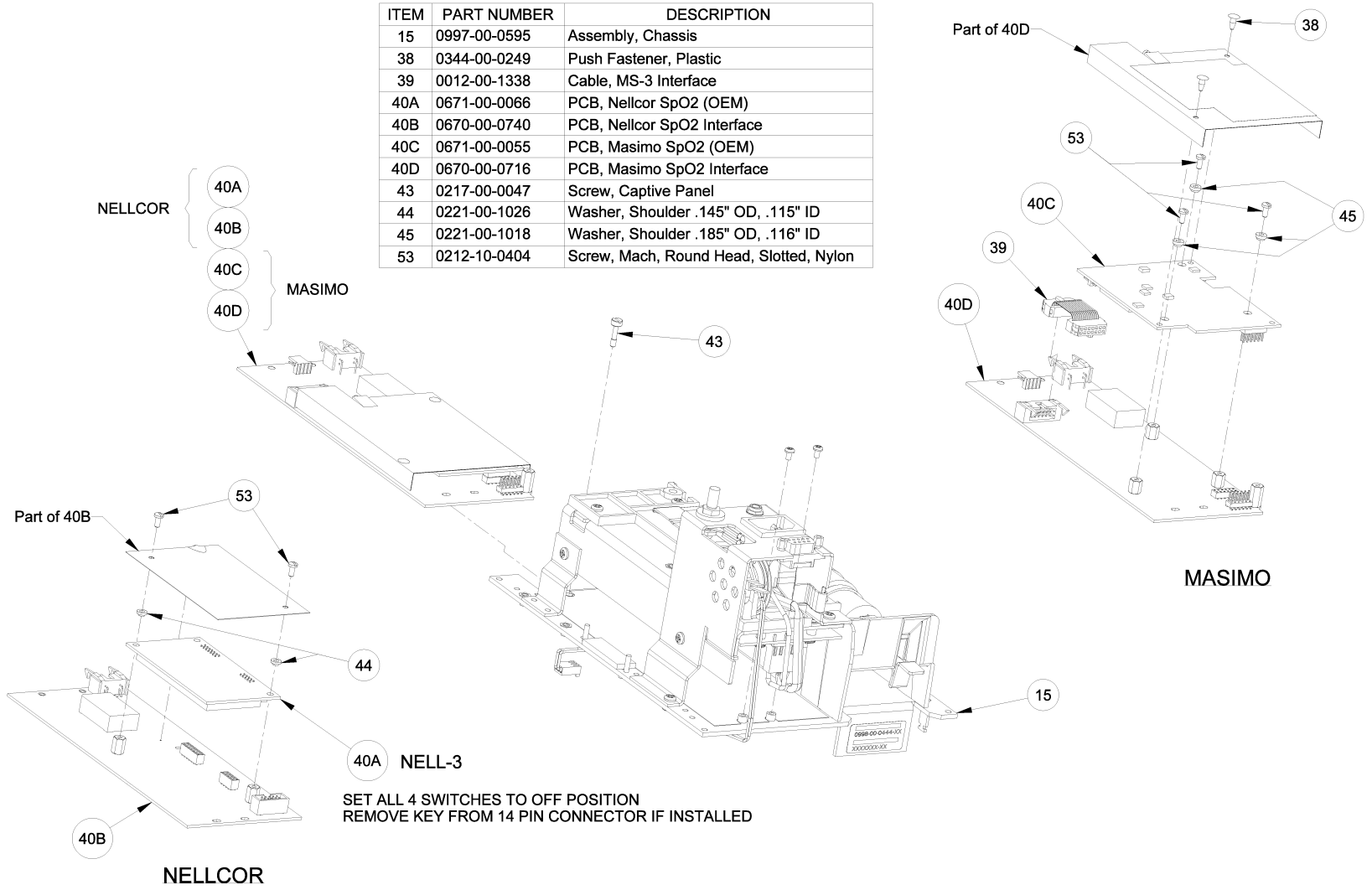
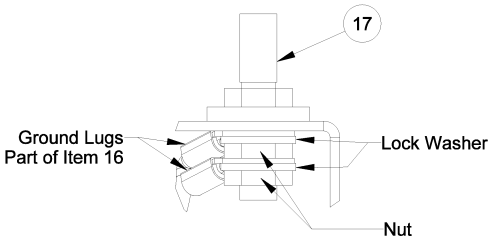
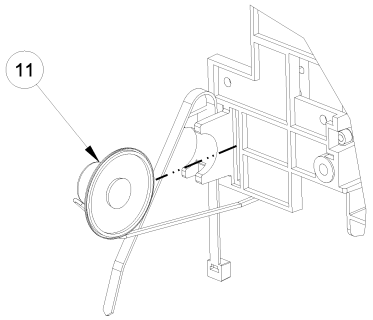


FIGURE 4-4

ITEM	PART NUMBER	DESCRIPTION
6	0012-00-1401	Cable and Connector, RS232/Nurse Call/Download
10	0361-00-0164	Jack Screws, RS232 Connector
11	0012-00-1720	Speaker with Cable
16	0012-00-1692	AC Mains Connector
17	0124-00-0104-06	Equipotential Lug
18	0105-00-0139	Battery Latch
20	0012-00-1693	Cable, Li-Ion Battery Connector
37	0104-00-0008	Pump, 12 VDC
37A	0012-00-1405	Cable, Pump





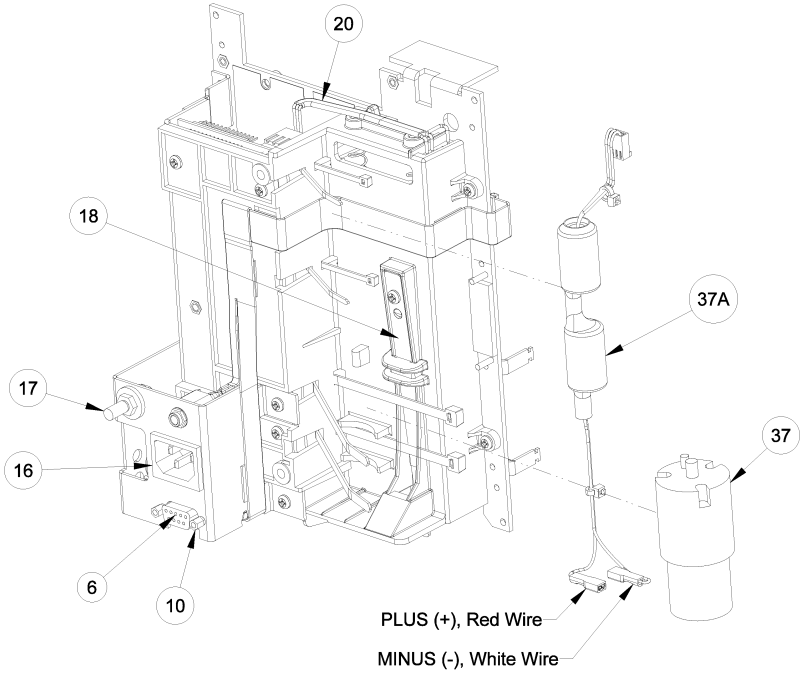


FIGURE 4-5

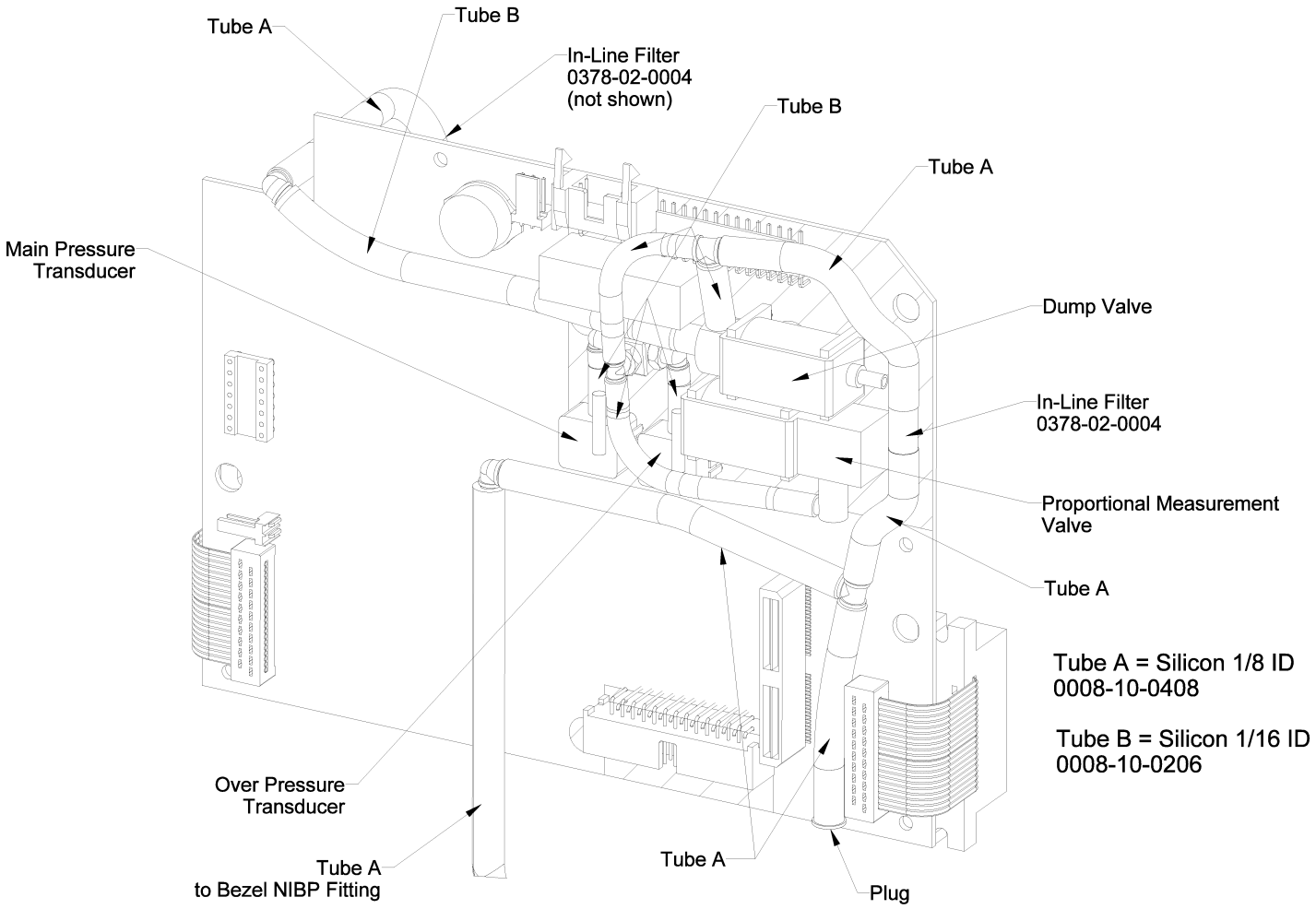


FIGURE 4-6 Non-invasive Tubing Diagram

4.8 Accessory Modules and Mounting Parts Lists

4.8.1 Recorder Module Replacement Parts List

DESCRIPTION	PART NUMBER
Chart Paper Door	0380-00-0274
Chart Cutter	0380-00-0275
Recorder Main Housing	0380-00-0273-01
Printer Assembly with printhead	0161-00-0015
Recorder, complete	0998-00-0127

4.8.2 Predictive Temperature Module Replacement Parts List

DESCRIPTION	PART NUMBER
Temperature probe input connector	0012-00-1335
Temperature probe, Adult, Oral	0206-00-0725-01
Temperature probe, Adult, Rectal	0206-00-0725-02
Temperature probe covers, box of 500	0198-00-0012-03
Complete replacement Predictive Temperature module with 2 probes and 1 box of probe covers	0998-00-0129

4.8.3 Universal Rolling Stand (P/N ACCTROLLSTD, Assembly Parts List)

CALLOUT NUMBER	DESCRIPTION	PART NUMBER
1	Basket	0202-00-0166
2	Casters, Non-Locking Casters, Locking	0401-00-0045 0401-00-0046
3	Mounting Bracket for Accutorr Plus, includes mounting screws	0406-00-0855-01
–	Complete Rolling Stand and Mounting Bracket Assembly	ACCTROLLSTD

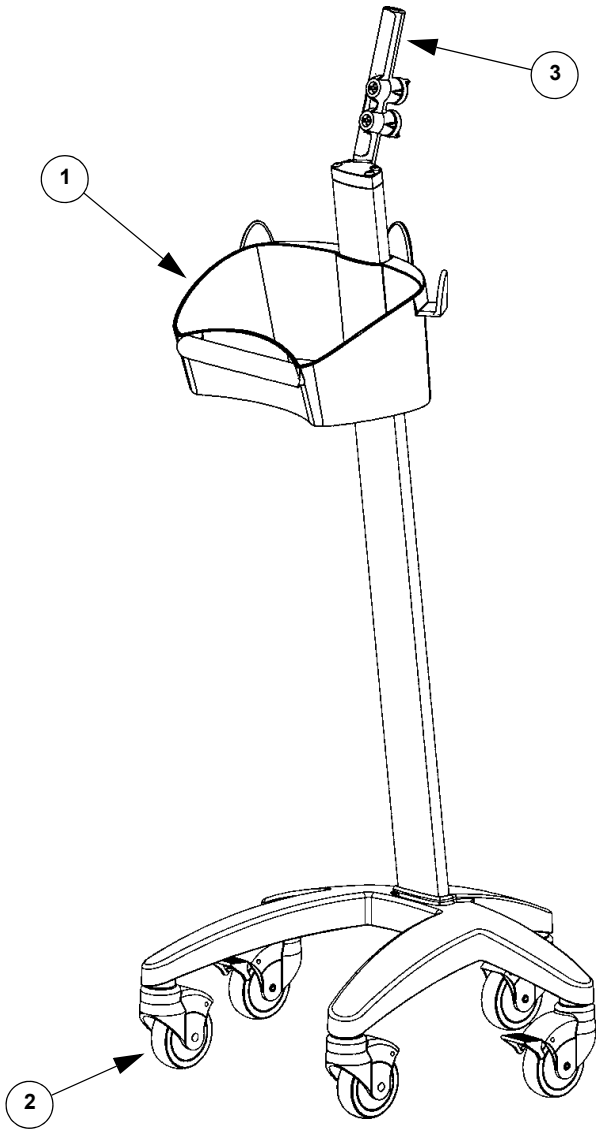


FIGURE 4-7 Accutorr Plus Rolling Stand (P/N ACCTROLLSTD)

4.8.4 Mounting Options

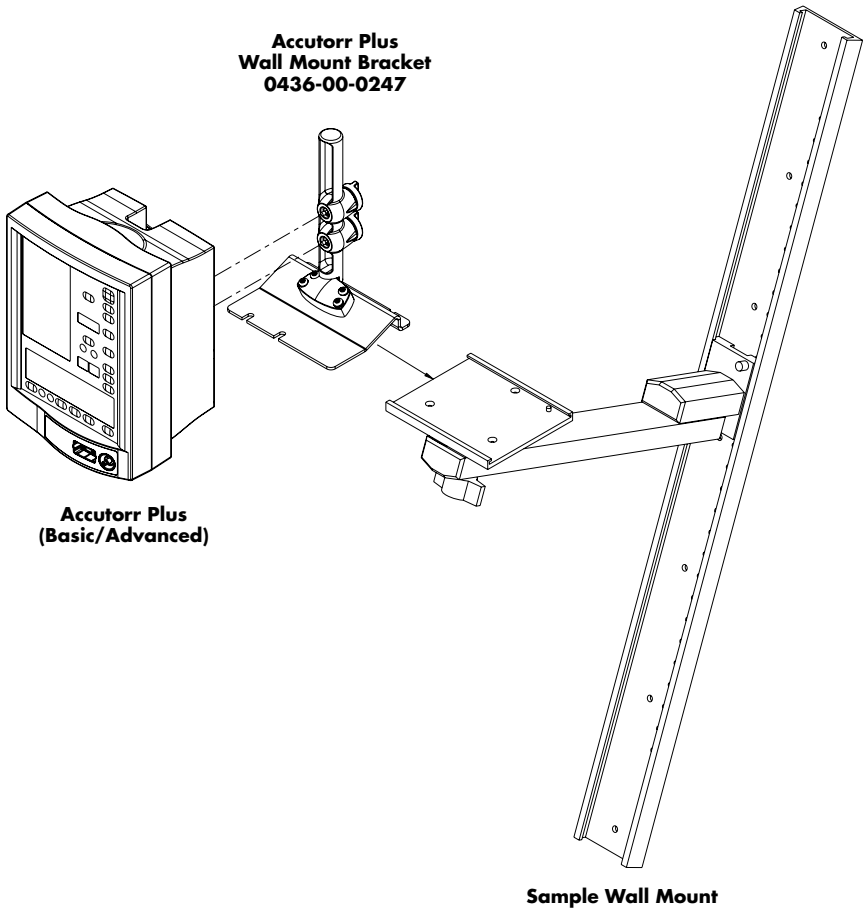


FIGURE 4-8 Accutorr Plus Mounting Options

5.0 Calibration

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5.2 Precautions And Guidelines 5-4
5.3 Test Equipment And Special Tools Required 5-4
5.4 Power-up Sequence, Internal Testing 5-4
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5.9 Trend Memory Initialization 5-19
5.10 SpO2 Normal Operation (Accutorr Plus model with SpO2) 5-20

5.1 Introduction

The Accutorr Plus is a state of the art device employing digital determination and verification systems to obtain superior performance for the life of the product. Most function calibration constants are written into the operating software, therefore, for the most part, there are no means to calibrate or adjust system functions. The instrument contains extensive Service Diagnostics that will, in most cases, isolate a malfunction to the lowest serviceable module.

NOTE: This procedure refers to this instrument as the UUT (Unit Under Test).

All internal verifications and adjustments should be performed with the internal battery disconnected. Operate the UUT on the main power supply. This will insure a reliable power source for the test, as well as providing a measure of safety in case of accidental overload of the power source. To re-initialize the low battery detector circuits, reconnect the battery at the conclusion of all tests while the UUT is on A.C. power source. Reset the real-time clock and date, if required.

5.1.1 Status and Error Code Table

The Accutorr Plus uses the various displays on the front panel to display the operational status. Error codes listed below can generally be resolved by the user however, error codes with an asterisk (*) may require resolution by a qualified technical service person.

5.1.1.1 Error Codes

Table 5-1

TYPE	CODE	DESCRIPTION	REASON
NIBP	8810	Retry - Unable to Measure	Motion artifact, cycle time-out, weak pulsations or no pulsations. A triple beep tone is generated.
	8811	Retry - Pump Higher	Insufficient cuff pressure. A triple beep tone is generated.
	8812	Stop - Cuff Overpressure	Excessive cuff pressure detected by the software. A triple beep tone is generated.
	8813	Stop - Unable to Measure	4 successive measurement attempts failed. A triple beep tone is generated.
TEMP (PTM)	8830	Check Probe	Tissue contact may have been lost.
	8831	Replace Probe	Defective probe or connection.

Table 5-1

TYPE	CODE	DESCRIPTION	REASON
SpO_2	8850	No Sensor	No sensor connected.
	8851	Sensor Off	Sensor not on patient. (Masimo® SpO_2 only)
	8852	Interference	Interference on signal. (Masimo® SpO_2 only)
	8853	Pulse Search	Unit cannot find signal. (Nellcor® SpO_2 module will report "Pulse Search"-8853- when the sensor is not on the patient.)
	8854	Weak Pulse	Weak pulse detected. (Masimo® SpO_2 only)
	8856	Check Sensor	Sensor problem. (Masimo® SpO_2 only)
	8857	PR<21	Pulse rate is less than 21 bpm. (Nellcor® SpO_2 only)
	8857	PR<26	Pulse rate is less than 26 bpm. (Masimo® SpO_2 only)
	8858	PR>249	Pulse rate is greater than 249 bpm. (Nellcor® SpO_2 only)
	8858	PR>239	Pulse rate is greater than 239 bpm. (Masimo® SpO_2 only)
SYSTEM	984*	NIBP Hardware Failure	NIBP A/D failure detected.
	985*	NIBP Overpressure Circuit not Programmed	The overpressure circuit is not set to the current patient size.
	986*	NIBP Overpressure Circuit not Tracking	The two pressure transducers are not tracking each other.
	987*	Stop - Hardware Overpressure	Excessive cuff pressure detected by hardware overpressure sensor. A triple beep tone is generated.
	988*	TEMP Bad Calibration	Thermometer needs calibration.
	990*	TEMP Illegal Mode	Thermometer switch is set wrong.
	991*	TEMP Module Failed	Thermometer internal failure.
	995*	SpO_2 Uncalibrated	SpO_2 fails calibration check.
	996*	SpO_2 Failure	SpO_2 failed self-test.

5.2 Precautions And Guidelines

In the event that the instrument covers are removed, observe these following precautions and general guidelines:

- Do not short component leads together.
- Perform all steps in the order given.
- Use extreme care when reaching inside the opened instrument. Do not contact exposed metal parts which may become live.

Read through each step in the procedure so it is understood prior to beginning the step.

5.3 Test Equipment And Special Tools Required

Equipment types other than these listed may be utilized if they equal or exceed the listed equipment performance.

- Non-Invasive Blood Pressure Simulator
- Stopwatch
- SpO_2 Simulator
- RS232 Test Connector (pins 2 and 3 shorted), 9-pin male “D” and software download port tester
- Phono plug (tip and ring shorted)
- 700 cc Dummy Cuff (P/N 0138-00-0001-01)
- Chart Paper (P/N 0683-00-0447-01)
- Water Bath, stirred, heated 80° to 120° F
- Reference Thermometer, 0.1%

5.4 Power-up Sequence, Internal Testing

1. Attach the AC power cord into the UUT rear panel AC Input module.
2. Press the **ON/STANDBY** key to turn the UUT On. The UUT automatically performs internal self diagnostics. The Timer / Temp. display starts a count down from 20. This is the initial software verification. Allow the unit to complete the start up sequence until there is a single LED light steadily illuminated above the Patient Setup key. After the initial power up sequence, “a” is displayed in the bed LED, and “0” is displayed in the Room LEDs.
3. Press the **ON/STANDBY** key to turn the UUT off.

5.5 Service Diagnostics

The Service Diagnostics tests must be run in the sequence indicated. The numbers and letters in parentheses after the title of each test, represent the room number and bed letter used to access the test.

5.5.1 Introduction (Hidden Key)

To enter the Service Diagnostics mode, while powering on the unit, press and hold the hidden key until two beeps are heard. The hidden key is the Adult symbol above the Patient **SETUP** key.

Verify that after the initial power up sequence a “0” is displayed in the Room LED, “a” is displayed in the Bed LED, and “ddd” is displayed in the Systolic LEDs.

5.5.2 Software Version Test (0a, 0b)

This test displays the installed software version (s) in the monitor. The results are displayed in the read outs illustrated in Figure 5-1 on page 5-6.

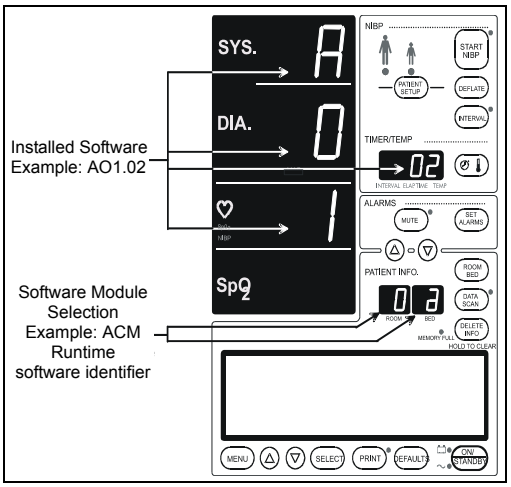

FIGURE 5-1 - Software Version Test

Confirm that the ROOM number is at “0”; otherwise use the **“ROOM/BED”** key to select the “ROOM”, and the **UP/DOWN** keys to set Room number to “0”.

Press **ROOM/BED** key to select BED. Use the **UP/DOWN ARROW** keys to select test “a” or “b”. Monitors without SpO_2 option may not display results for tests “0c” and “0d”. Press ROOM/BED again to lock in selection.

Press the START **NIBP** key.

Press the **DEFLATE** key until a beep is heard. This allows a selection of the next test.

Repeat process for test “b”.

Table 5-2

DESCRIPTION OF SOFTWARE MODULE	TEST ROOM NUMBER	SUB TEST PATIENT BED LETTER
ACM Runtime Software Version	0	a
ACM Boot Software Version	0	b

5.5.3 Keypad Test

1. Press the Room Up arrow to change the Room Number to “1”.
2. Press the Start **NIBP** key to run the keypad test.
3. Press any key on the keyboard. A number will appear in the Patient Bed Letter Display. This number is identified in Figure 5-1 on page 5-6. Verify that the correct number appears in the Patient Bed Letter Display when each key is pressed.

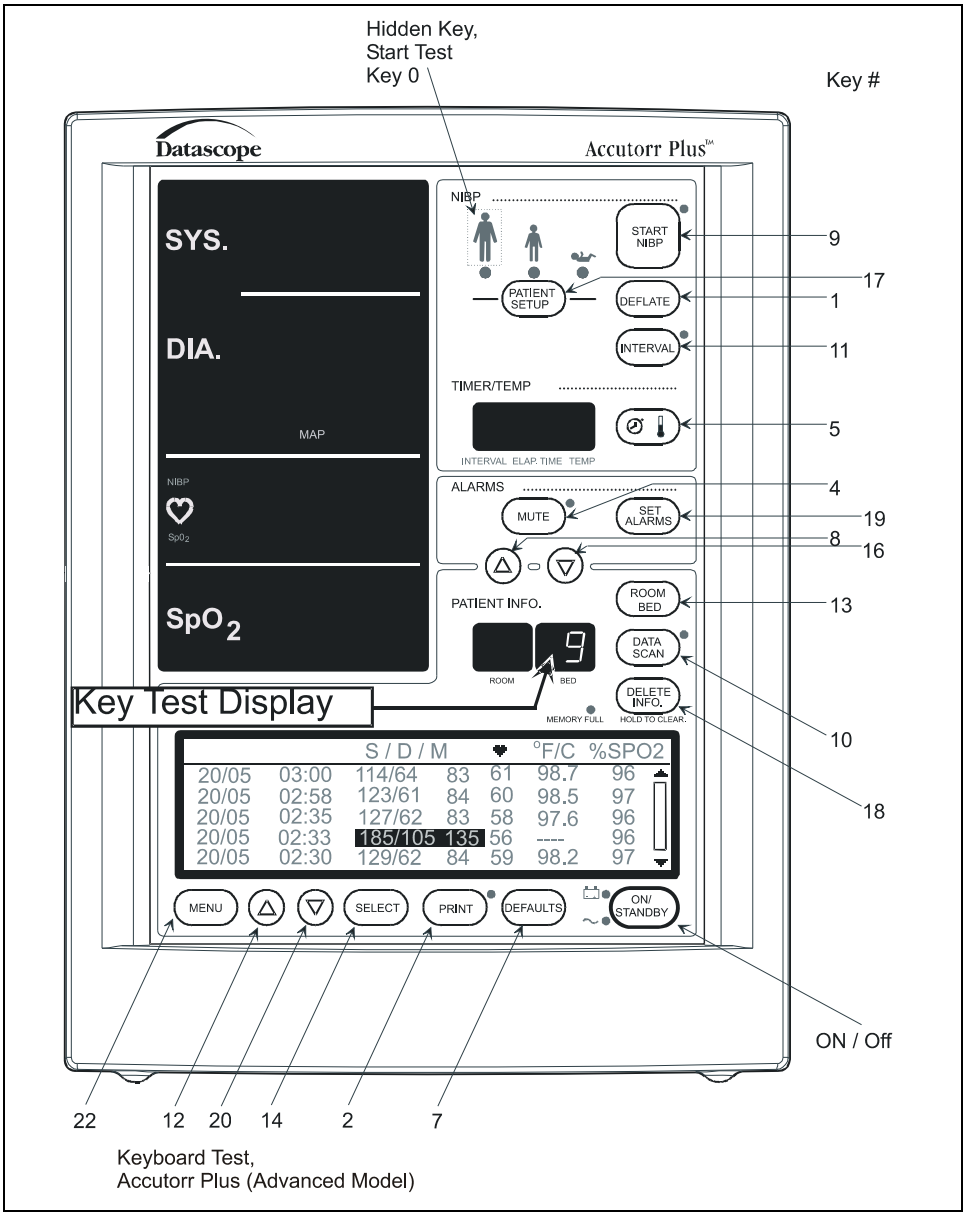

FIGURE 5-2

4. Press the **DEFLATE** key for 3 seconds to exit keypad test.

5.5.4 LED Test (2a, 2b)

This test allows the LED function to be verified by driving all seven LEDs with numbers from 0 to 9, in sequential order. For this test, all annunciator LEDs turn on for 1 second.

Table 5-3

TEST DESCRIPTION	TEST ROOM NUMBER	SUB TEST PATIENT BED LETTER
7 Segment LED Test	2	a
Annunciator LED Test	2	b

5.5.5 Communication Test (3a, 3b)

This test checks the integrity of the external communication systems. Test 3a checks the external RS232 interface and requires that the transmit and receive pins be connected together. Test 3b checks the Download port and requires that the tip (transmit) and ring (receive) pins be connected together. The CRC table is transmitted and received. If the CRC data received matches the CRC table transmitted, the test passes; otherwise a failure is reported.

Table 5-4

TEST DESCRIPTION	SHORT CONNECTOR PINS	TEST ROOM NUMBER	SUB TEST PATIENT BED LETTER
RS232 Port Test	Transmit (2) and Receive (3)	3	a
Download Port Test	Tip and Ring	3	b

5.5.6 Recorder Test (4)

1. Select Room Number 4 and press the NIBP **START** key to activate the test. This test prints out a pattern on the recorder if a recorder module is attached. A strip similar to Figure 5-3 will be printed.

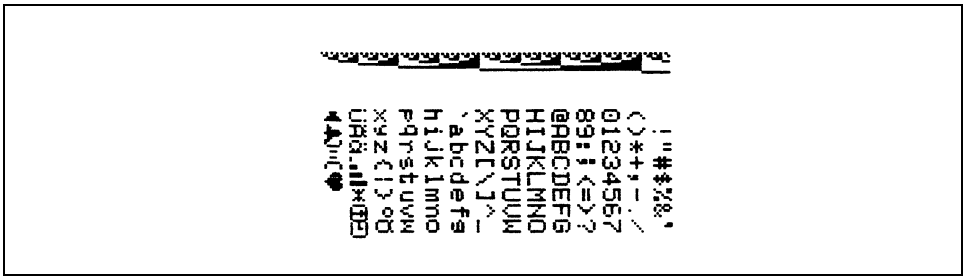

FIGURE 5-3

5.5.7 Pump Test (5)

NOTE: 700 cc dummy cuff must be used.

Select Room Number 5 and press NIBP **START** key to activate the test.

This test evaluates the ability of the pump to pressurize a fixed volume representative of an adult cuff to a typical adult pressure.

A fixed volume of 700 cc is pumped to a pressure of 300 mmHg. While the pump is operational, the elapsed time is displayed in the Timer/Temperature display. When the target pressure is reached, the elapsed time display holds its current reading and the pump deflates the chamber for another test. The test passes if the chamber is inflated in less than 35 seconds. Pressing the **DEFLATE** key at any time *during* the test causes the NIBP module to open all valves to release the pressure, clear the MAP display, and exit the test. Pressing the **DEFLATE** key *after* the test is completed will clear the MAP display and exit the test.

5.5.7.1 Bleed Rate Test (6a, 6b)

NOTE: 700 cc dummy cuff must be used.

Press the NIBP **START** key to activate the selected test. See Table 5-5 on page 5-9.

This test evaluates the ability of the instrument to maintain a constant bleed rate, for the purpose of accurate and repeatable NIBP measurements. This test also evaluates the ability of the system to reduce cuff pressure quickly.

A fixed volume of 700 cc is pumped to approximately 20 mmHg over the specified start pressure (see Table 5-5 on page 5-9), then vented to atmosphere through one of two different valves. During the test, the MAP display indicates the real-time system pressure and the Timer/Temperature display indicates the elapsed time in seconds. When the stop pressure is reached, the MAP display is blanked and the elapsed time displays the current reading. Pressing the **DEFLATE** key deflates the chamber, clears the MAP display, and exits the test. Each test is uniquely identified in the Patient Bed Letter Display as described in Table 5-5 on page 5-9. The table identifies each test, the corresponding start and stop pressures and required completion times.

Table 5-5

TEST DESCRIPTION	START PRESSURE (MMHG)	STOP PRESSURE (MMHG)	TIME (SEC.)	TEST ROOM NUMBER	SUB TEST PATIENT BED LETTER
Linear Bleed Valve Test	180	60	15-25 secs.	6	a
Dump Valve Test	250	20	14 sec. max.	6	b

5.5.8 Leak Test (7)

NOTE: 700 cc dummy cuff must be used.

Select Room Number 7 and press the NIBP **START** key to activate the test.

This test evaluates the ability of the system to maintain a steady pressure.

A fixed volume is pumped up to an initial differential pressure of approximately 250 mmHg and monitored for a fixed period of time. While the pump is operational, peak pressure is displayed in the MAP display. When the target pump pressure is reached, the peak pressure is frozen in the MAP display during a five second dwell. During leakage measurement, the current pressure leakage is displayed in the MAP display and the elapsed test time (in seconds) is displayed in the Temperature/Time/Interval display. After the leakage measurement time has elapsed, the MAP and Temperature/Time/Interval displays are blanked and a “00” (Pass) or “FF” (Fail) will be displayed in the Bed window. Pressing the **DEFLATE** key at any time *during* the test causes the NIBP module to open all valves to release the pressure, clear the MAP display, and end the test. The maximum pressure drop is no more than 10 mmHg in any 90 second period when connected to a 700 cc volume. Pressing the **DEFLATE** key *after* the test is completed will clear the MAP display and exit the test.

5.5.9 Over Pressure Test (8a, 8b, 8c)

NOTE: 700 cc dummy cuff must be used.

Select Room Number and Bed Letter per Table 5-6 on page 5-10. Press the NIBP **START** key to activate the test.

This test evaluates the ability of the system to prevent an over pressure condition, independent of software control, for each of 3 over pressure settings. A fixed volume of 700 cc’s is pumped to a target pressure that is above the maximum over pressure specified for the respective over pressure limit (see Table 5-6 on page 5-10), while displaying the real-time system pressure in the MAP display. For this test, the software over pressure monitor is disabled. On completion, the MAP display indicates the maximum pressure reached and the Patient Bed Letter Display indicates if the over pressure sensor was activated (00) or not (FF). Pressing the **DEFLATE** key at any time during the test causes the NIBP module to open all valves to release the pressure and end the test.

Following each overpressure hardware test, the UUT must be turned off and rebooted in the diagnostic mode in order to re-enable the pump.

Table 5-6

TEST SIZE/MODE	TARGET PUMP PRESSURE (MMHG)	TEST ROOM NUMBER	SUB TEST PATIENT BED LETTER
Low	157, ±5	8	a
Medium	210, ±10	8	b
High	315, ±15	8	c

5.5.10 Pulse Channel DC Offset Test (9a, 9b, 9c)

Select Room Number and Bed Letter per Table 5-7 on page 5-11, and press the NIBP **START** key to activate the test.

This test measures the DC offset for each of the three electronic gain settings available on the pulse channel. Results for each gain setting are displayed in the Timer/Temperature display (in Volts). Table 5-7 on page 5-11 describes the tests performed.

Press the **DEFLATE** key after each test to exit.

Table 5-7

TEST DESCRIPTION	ACCEPTABLE LIMIT (V)	TEST ROOM NUMBER	SUB TEST PATIENT BED LETTER
Gain 1 (Low) Test	1.50 to 1.83	9	a
Gain 2 (Med) Test	1.50 to 1.83	9	b
Gain 3 (High) Test	1.50 to 1.83	9	c

5.5.11 Pulse Channel Average Noise Test (10a, 10b, 10c)

Select Room Number and Bed Letter per Table 5-8 on page 5-11, and press the NIBP **START** key to activate the test.

This test measures the average noise for each of three electronic gain settings available on the pulse channel. Results for each gain setting are displayed in the Timer/Temperature display (in millivolts). Table 5-8 on page 5-11 describes the tests performed.

Press the **DEFLATE** key after each test to exit.

Table 5-8

TEST DESCRIPTION	ACCEPTABLE LIMIT (MV)	TEST ROOM NUMBER	SUB TEST PATIENT BED LETTER
Gain 1 (Low) Test	<25	10	a
Gain 2 (Med) Test	<50	10	b
Gain 3 (High) Test	<75	10	c

5.5.12 Main Pressure Transducer Verification Test (11a, 11b, 11c)

NOTE: 700 cc dummy cuff must be used.

This tests the calibration of the main pressure transducer in LOW, MED, and HIGH modes. This is done by comparing the readings of the UUT to an external pressure gauge in LOW mode below 100 mmHg, in MED mode between 100 mmHg to 200 mmHg, and in HIGH mode between 200 mmHg to 300 mmHg. In the event of a disagreement between the device and an external gauge, the transducer must be calibrated by performing the calibration in section 5.5.15 “Main Pressure Transducer Calibration” on page 5-14.

1. Select diagnostic test “11” (Room) “a” (Bed).

2. Press the **START** NIBP key to start the LOW calibration test. Verify that the pump comes on, the pressure increases, and then the pump stops. After 10 seconds, verify that the pressure settles below 100 mmHg. Compare the final pressure displayed to an accurate external pressure gauge. The MAP LEDs reading should agree within ±1% with the external pressure gauge. If it does not agree, a failure has occurred and proceed to section 5.5.15 “Main Pressure Transducer Calibration” on page 5-14.
3. Press the **DEFLATE** key to release the pressure and exit the test.
4. Select diagnostic test “11” (Room) “b” (Bed).
5. Press the **START** NIBP key to start the MED calibration test. Verify that the pump comes on, the pressure increases, and then the pump stops. After 10 seconds, verify that the pressure settles between 100 mmHg and 200 mmHg. Compare the pressure displayed to an accurate external pressure gauge. The pressure MAP LEDs reading should agree within ±1% with the external pressure gauge. If it does not agree, a failure has occurred and proceed to section 5.5.15 “Main Pressure Transducer Calibration” on page 5-14.
6. Press the **DEFLATE** key to release the pressure and exit the test.
7. Select diagnostic test “11” (Room) “c” (Bed).
8. Press the **START** NIBP key to start the HIGH calibration test. Verify that the pump comes on, the pressure increases, and then the pump stops. After 10 seconds, verify that the pressure settles between 200 mmHg and 300 mmHg. Compare the final pressure displayed to an accurate external pressure gauge; the MAP LEDs reading should agree within ±1% with the external pressure gauge. If it does not agree, a failure has occurred and proceed to section 5.5.15 “Main Pressure Transducer Calibration” on page 5-14.
9. Press the **DEFLATE** key to release the pressure and exit the test.

5.5.13 Verification of Accutorr Plus Pneumatic Performance using an NIBP Simulator (11d)

Select Room Number 11 and Bed Letter d, and press the NIBP **START** key to activate the test.

For these tests, program the NIBP simulator to perform the desired test. Instead of pumping up the cuff, this test uses the NIBP simulator to verify the Accutorr Plus pressure reading for the NIBP Leak Test, Over Pressure test, and the Main Pressure Transducer Verification Test. The Accutorr displays the pressure in the MAP display. Pressing the **DEFLATE** key at any time during the test causes the NIBP module to open all valves, clear the MAP display, and exit the test. The NIBP simulator must be exited separately.

NOTE: The reading and setting accuracy will be dependent on the accuracy of the NIBP simulator and the condition of the Accutorr Plus.

The NIBP standard dynamic pressure simulation may produce Systolic / Mean / Diastolic read outs on the Accutorr Plus outside of the specified limits. The pressure simulation results may not be accepted as a measure of the Accutorr Plus clinical performance.

5.5.14 Overpressure Transducer Verification <12c, 12a, 12b>

This test verifies that the overpressure transducer is calibrated correctly. Calibration is checked in the Low level pressure mode so that the limit displayed in the MAP window should say 158 mmHg (±1). If it does not, the transducer needs to be calibrated by proceeding to 5.5.16 “Overpressure Transducer Calibration” on page 5-15. The overpressure transducer should also be verified in the High and Mid level pressure modes.

1. Select diagnostic test “12” (Room) “a” (Bed). Low Limit
2. Press the **START** NIBP key to start the test.
3. Verify that the overpressure value displayed in the MAP LEDs is 158 mmHg (±1).
4. Repeat steps 1 through 3, but select test “12” “c” to check overpressure limit, 315 mmHg (±15); and test “12” “b” for Mid level overpressure limit, 210 mmHg (±10).
5. Press the **DEFLATE** key to exit this test.

5.5.15 Main Pressure Transducer Calibration

NOTE: This procedure should only be performed in the event that there was a failure in 5.5.12 “Main Pressure Transducer Verification Test (11a, 11b, 11c)” on page 5-11.

NOTE: 700 cc dummy cuff must be used.

This is the procedure for calibrating the main pressure transducer in the event that there is a disagreement between the UUT and the external pressure gauge in the proceeding test. The device is calibrated by comparison with the NIBP simulator at 158 mmHg (±1) and then by adjusting R540 on the 0670-00-0814 PCB (see Figure 5-5).

1. Connect the NIBP simulator to the Accutorr Plus cuff connector, and connect a 700 cc test chamber to the open port of the simulator. Select the manometer function of the simulator.
2. Select diagnostic test “11” (Room) “d” (Bed).
3. Press the **START** NIBP Key to start HIGH calibration procedure.
4. Pump up the NIBP simulator to 158 ±1mmHg.
5. Allow pressure to stabilize for 10 seconds. Read the pressure in the MAP display.
6. Adjust R540 on the 0670-00-0814 PCB until the MAP readout is the same as the simulator’s manometer reading.
7. Press the **DEFLATE** key to exit this test.
8. Repeat 5.5.12 “Main Pressure Transducer Verification Test (11a, 11b, 11c)” on page 5-11.

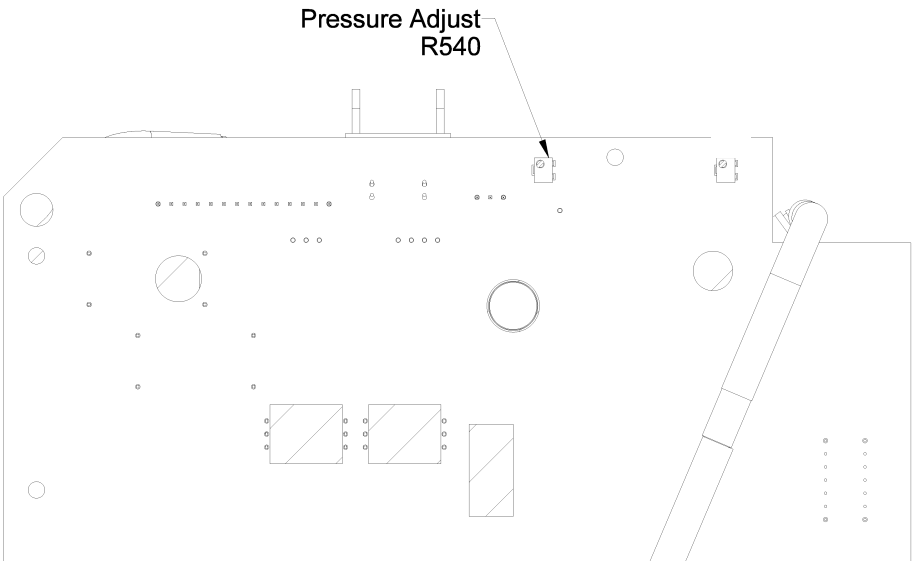

FIGURE 5-4 Pressure Adjust (R540)

5.5.16 Overpressure Transducer Calibration

NOTE: This procedure should only be performed if a failure occurred in steps 1 through 3 of 5.5.14 “Overpressure Transducer Verification <12c, 12a, 12b>” on page 5-13.

This is the procedure for calibrating the overpressure transducer in the event that the display does not read 158 mmHg during the test for Low pressure mode in 5.5.14 “Overpressure Transducer Verification <12c, 12a, 12b>” on page 5-13. The transducer is calibrated using R504 on the 0670-00-0814 PCB (see Figure 5-5).

1. Adjust R504 on the 0670-00-0814 PCB until the MAP readout is 158 mmHg.
2. Repeat 5.5.14 “Overpressure Transducer Verification <12c, 12a, 12b>” on page 5-13.

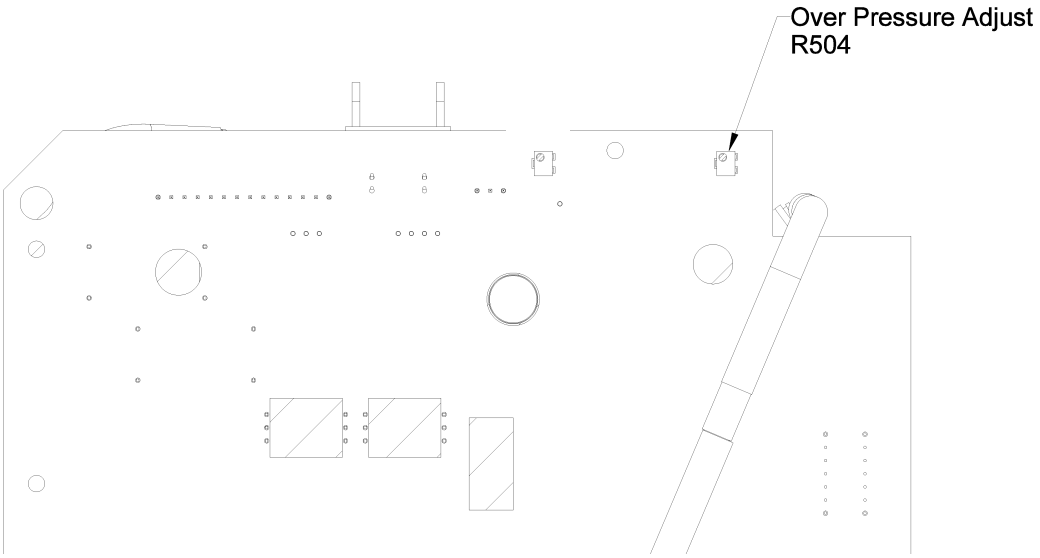

FIGURE 5-5 Overpressure Adjust (R504)

5.6 Predictive Thermometer Verification And Calibration

The Water Bath Method, utilizes laboratory grade stirred water bath to confirm that the PTM is operating within the specified limits.

In case of failure or inaccuracy of readings, the System Calibration Procedure may be followed to re-adjust the device to factory specifications.

This procedure requires high accuracy test equipment and therefore it is not recommended for field calibration. A comprehensive factory service program to support this product is available.

5.6.1 Water Bath Method

1. Prepare a water bath set to 89.6 to 110.0°F as a temperature reference. Confirm temperature with a separate precision thermometer.
2. Snap a protective sheath onto the temperature probe, and immerse into the reference water bath for 30 seconds, or until the temperature display stops flashing. Record the temperature shown on the temperature display.

5.6.2 Temperature Verification Test, Infrared Thermometer (Applicable Only To Units Equipped With A Temperature Option)

1. Pre-heat water bath to 100°F. Place floating Black Body device into water bath and allow to stabilize until step 7, or a minimum of 30 seconds.
2. Prepare the thermometer for the verification process, by removing any disposable probe covers. Clean the probe lens with a swab dipped in alcohol.
3. Completely cover probe tip with a piece of aluminum foil, from the lens to the probe neck portion. Allow 5 minutes for the probe and foil to stabilize at ambient temperature.
4. Activate the thermometer, by pressing the button. Read the ambient temperature displayed and record the number as T_A=____.
5. Remove the aluminum foil.
6. Check the water bath temperature against a laboratory grade mercury thermometer, with a verified accuracy of 0.4 °F (0.2 °C) or better. Record the water bath temperature as TT=____.
7. Attach a disposable probe cover to the thermometer head. Insert the head into the floating Black Body cavity, such that the instrument is looking into the needle shaped end.

8. Press the button to measure the temperature. Record the temperature as T_{DCALC}=____.
9. Select the appropriate correction factor from the following choices:
10. Core temperature correction: Kcore=1.087
11. Oral temperature correction: Kora=1.058
12. Rectal temperature correction: Krectal=1.095
13. The standard infrared thermometer is calibrated to indicate Core temperature, thus the correction factor to be used is K=1.087.
14. Calculate the display temperature according to the following formula:

    $K(T_T - T_A) + T_A = T_{dcalc}$ where:

    T_{dcalc} is Calculated Display Temperature.

    Kcore=1.087 Correction Factor for Core Temperature.

    T_T is Target Temperature.

    T_A is Ambient Temperature.

    Sample Calculation:

    Ambient temperature (T_A) measured: 72 °F

    Water Bath temperature (T_T) measured: 98.6 °F

    Correction Factor (K_{core})=1.087

    1.087 (98.6-72) + 72= 100.9 °F thus,

Temperature displayed by thermometer is 100.9 °F, and calculated temperature is 100.9 °F, the accuracy has been verified.

Temperature value deviations: The calculated value is a function of the accuracy of the water bath temperature. As an example, a ±1% reading error of water temperature will result in a ±1 °F reading input into the formula, resulting in a final calculated values of 99.9 to 101.9 °F.

With a display resolution of ±1 digit and an over all resolution of ±0.2 °F, the final, calculated reading may fall between 98.6 and 102.2.

5.6.3 Low Battery Sensing

The low battery threshold is not adjustable. When the battery has reached the low battery threshold, the power supply will report this condition to the CPU on the Accutorr Plus.

5.7 Setting the Current Time

1. Press and hold the **TIMER/TEMP** key for 6 seconds. The hour digit only displays.
2. Press the **UP** or **DOWN ARROW** key to change the number.
3. Press the **TIMER/TEMP** key to activate the minute display.

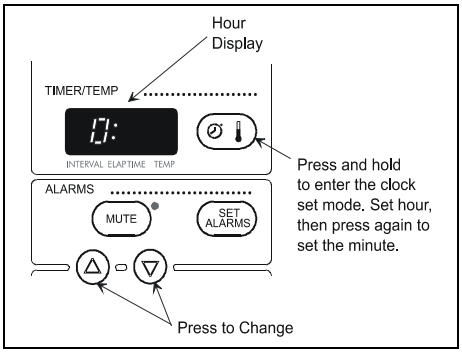

FIGURE 5-6 Hour Display

NOTE: The Accutorr Plus always displays time in a 24 hour format.

4. Press the **UP** or **DOWN ARROW** key (12 or 13) to change the number. Continue pressing the **TIMER/TEMP** key and the **ARROW** keys to set the month, day, and year (in that order).

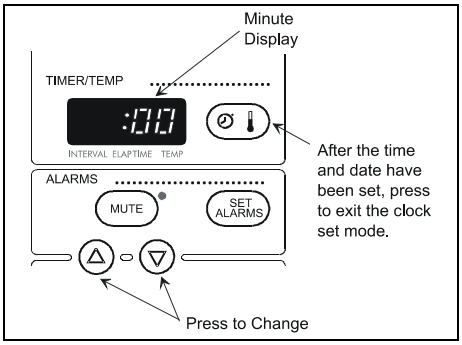

FIGURE 5-7 Minute Display

5.8 NIBP Normal Operation

1. Press the left **ARROW** key on the NIBP simulator to highlight SELECT BP, then press the **ENT** key. Set pressure test to 120/80 (90) and press the **ENT** key.
2. Select a NIBP simulation of 120/80 mmHg with a Heart rate of 60 BPM.
3. Attach the NIBP simulator to the input pressure fitting of UUT.
4. Press the **INTERVAL** key of the keypad until a 1 is shown in the Timer/Temp./ Interval LED of the UUT. Press the **PATIENT SIZE** key to select Adult size indicator.
5. Press the Set **ALARMS** key to enter the alarm setting mode. Use the **UP** and **DOWN ARROW** keys to set the Systolic Low alarm to 130 mmHg.
6. Press the Set **ALARMS** key again and set the Diastolic Low Alarm to 95 mmHg.
7. Press the Start **NIBP** key. Verify the monitor takes a measurement and the Systolic and the Diastolic low alarms are violated. The LEDs for these parameters will blink on and off and an alarm tone will sound for the violation. Press the **MUTE** Key to silence the alarms.
8. After the fifth measurement is complete, allow the cuff to pump up. Press **DEFLATE** key. Verify cuff deflates.
9. Review the data that was stored in the database, by scrolling through the patient trend information. Use the **UP** and **DOWN ROOM** and **BED** keys or LED display of the UUT and verify that the Systolic and Diastolic information is available in the LEDs for each stored settings
10. Remove the cuff from the UUT and press the **START** key. Confirm that the UUT pump runs and that it displays 8810 in the Room/Bed window within 60 seconds and attempts another inflation. Press the **DEFLATE** key to stop test.

5.9 Trend Memory Initialization

1. To clear the UUT Trend Memory for all patient settings, press and hold the **DELETE INFO.** key while powering up the unit.

5.10 SpO_2 Normal Operation (Accutorr Plus model with SpO_2)

The purpose of this test is to verify that an SpO_2 signal is recognized, alarm limits are captured and the data is trended. A full operational test may be conducted, if so warranted, within the limits of the published specification. See chapter 3 of this manual for specifications.

1. Set the simulator to an SpO_2 saturation level of 98%, pulse rate of 60 bpm, and a pulse amplitude of 100%.
2. Set the Accutorr Plus SpO_2 HI alarm limit to 95% and the pulse rate HI alarm limit to 55 bpm.
3. Connect an NIBP cuff or a suitable simulator to the Accutorr Plus and start a measurement.
4. Confirm that the Accutorr Plus has determined an SpO_2 saturation level and has violated the SpO_2 HI alarm and the pulse rate HI alarm (flashing digits and alarm tone). Press the **MUTE** key to silence the alarms.
5. Check the trend screen to confirm that the measurement information has been saved.
6. Set the SpO_2 HI alarm to OFF and SpO_2 LOW alarm to 86.
7. Set the simulator to an SpO_2 saturation level of 90%, pulse rate of 95 bpm, and the pulse amplitude to approximately 10% (low perfusion Masimo® SpO_2 only).
8. The Accutorr Plus may intermittently determine SpO_2 values or indicate a status code of 8853 (Pulse Search) or 8854 (Weak Pulse / Low Perfusion will display). Adjust the simulators pulse amplitude up and down until either status code of 8853 or 8854 displays.
9. Restore normal simulation parameters as described in step 1.
10. Remove the sensor from the simulator to induce a status code of 8851 (Sensor Off) (Masimo® SpO_2 only).
11. Disconnect the sensor from the Accutorr Plus to produce a status code of 8850 (No Sensor).

6.0 Preventive Maintenance

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6.3 Preventive Maintenance Schedule 6-2

6.1 Introduction

The intent of this procedure is to ensure that the product continues to be safe and effective in its intended environment. Complete knowledge of the instrument characteristics and its relationship to the clinical environment are useful in determining changes in the performance of the monitor, and the clinical limitations of the device.

As a general rule, the instrument is not tested to the full limits of it's capabilities at each service interval. Rather, representative points are tested and the results recorded. It is important to note that while not all functions are tested to the absolute limits, every function and option should be exercised. Declining performance over time is frequently the first indication of the need for more extensive service action.

6.2 Limitations Of Physiological Simulators

The physiological simulator is the principle aid for problem solving. Simulators have many of the same limitations as the devices that they will test. It is imperative that the simulator correlate well to a "Reference Standard*". The electronic simulators available attempt to replicate a broad spectrum of indices representative of normal and abnormal physiological events, within the interpretation of the manufacturer.

Most simulators (properly maintained) will provide reasonably accurate and consistent results, but may not produce the exact results when connected to similar monitors from different manufacturers. However, the consistent performance of a simulator is a good indicator of any change in the performance in the monitor.

* *For example, an accurate mercury column for pressure verification.*

6.3 Preventive Maintenance Schedule

The following preventive maintenance steps are required for continued satisfactory performance and safety of the Accutorr Plus and optional accessories. Inspections and replacement of consumable supplies and accessories that are subject to normal wear, must be accomplished at least as frequently as the inspection of the host unit. Read the Warranty statement in the Operating Instructions for description of warranty conditions.

The suggested minimum maintenance schedule is based on normally expected wear and tear of system and components. The intervals may be shortened at the user's discretion when conditions of use may warrant. In case of internal instrument failure, component replacement, and possible or actual instrument damage, it is strongly recommended that complete performance and safety verification be conducted.

6.3.1 Mechanical and Physical Visual Inspection (One Year Interval)

Check the following items for wear and physical damage: Repair or replace as needed.

- Outer case of Accutorr Plus, Recorder and Temperature module.
- Patient connected accessories such as blood pressure cuffs and hoses and related connectors. Check the SpO_2 sensor and cables. Check the temperature cables and probes. Verify and replenish the disposable items as needed. (i.e.,: probe covers, recorder chart supply).
- Power cords, external safety ground connections and communication cables.

6.3.2 Electrical Safety and Performance Checks (One Year Interval)

- Line power and battery power indicator lights functional in the proper modes.
- Line power and safety grounds are intact and within specifications.
- Non-invasive blood pressure section is functional within specifications.
- SpO_2 functions are operational and within specification.
- Temperature functions are operational and within specifications.
- Recorder is functional and documents available stored data.
- Check recorder paper path and clean as required.
- Error codes, failure messages, end user reported anomalies are collected and analyzed for reduced performance trends. Identify and correct causes as warranted.
- Perform ground resistance and chassis leakage tests.

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